ANNALS

OF THE

NEW YORK

ACADEMY OF SCIENCES

VOLUME XVII

1906 – 1907

Editor:
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New York
Published by the Academy

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[ANNALS N. Y. ACAD. SCI., VOL. XVII. Pages i–xxxvi.]

THE ORGANIZATION OF THE NEW YORK ACADEMY OF SCIENCES.

THE ORIGINAL CHARTER.

AN ACT TO INCORPORATE THE

LYCEUM OF NATURAL HISTORY IN THE CITY OF NEW YORK.

Passed April 20, 1818.

WHEREAS, The members of the Lyceum of Natural History have petitioned for an act of incorporation, and the Legislature, impressed with the importance of the study of Natural History, as connected with the wants, the comforts, and the happiness of mankind, and conceiving it their duty to encourage all laudable attempts to promote the progress of science in this State—therefore,

1 *Be it enacted by the People of the State of New York represented in Senate and Assembly,* That Samuel L. Mitchill, Casper W. Eddy, Frederick C. Schaeffer, Nathaniel Paulding, William Cooper, Benjamin P. Kissam, John Torrey, William Cumberland, D'Jurco V. Knevels, James Clements, and James Pierce, and such other persons as now are, and may from time to time become members, shall be, and hereby are constituted a body corporate and politic, by the name of LYCEUM OF NATURAL HISTORY IN THE CITY OF NEW YORK, and that by that name they shall have perpetual succession, and shall be persons capable of suing and being sued, pleading and being impleaded, answering and being answered unto, defending and being defended, in all courts and places whatsoever; and may have a common seal, with power to alter the same from time to time; and shall be capable of purchasing, taking, holding, and enjoying to them and their successors, any real estate in fee simple

or otherwise, and any goods, chattels, and personal estate, and of selling, leasing, or otherwise disposing of said real or personal estate, or any part thereof, at their will and pleasure: *Provided always*, that the clear annual value or income of such real or personal estate shall not exceed the sum of five thousand dollars: *Provided*, however, that the funds of the said Corporation shall be used and appropriated to the promotion of the objects stated in the preamble to this act, and those only.

2. *And be it further enacted* That the said Society shall from time to time, forever hereafter, have power to make, constitute, ordain, and establish such by-laws and regulations as they shall judge proper, for the election of their officers; for prescribing their respective functions, and the mode of discharging the same; for the admission of new members; for the government of the officers and members thereof; for collecting annual contributions from the members towards the funds thereof; for regulating the times and places of meeting of the said Society; for suspending or expelling such members as shall neglect or refuse to comply with the by-laws or regulations, and for the managing or directing the affairs and concerns of the said Society: *Provided* such by-laws and regulations be not repugnant to the Constitution and laws of this State or of the United States.

3. *And be it further enacted*, That the officers of the said Society shall consist of a President and two Vice-Presidents, a Corresponding Secretary, a Recording Secretary, a Treasurer, and five Curators, and such other officers as the Society may judge necessary; who shall be annually chosen, and who shall continue in office for one year, or until others be elected in their stead; that if the annual election shall not be held at any of the days for that purpose appointed, it shall be lawful to make such election at any other day; and that five members of the said Society, assembling at the place and time designated for that purpose by any by-law or regulation of the Society, shall constitute a legal meeting thereof.

4. *And be it further enacted* That Samuel L. Mitchill shall be the President; Casper W Eddy the First Vice-President; Frederick C. Schaeffer the Second Vice-President; Nathaniel Paulding, Corresponding Secretary; William Cooper. Record-

ing Secretary; Benjamin P. Kissam, Treasurer, and John Torrey, William Cumberland, D'Jurco V. Knevels, James Clements, and James Pierce, Curators; severally to be the first officers of the said Corporation, who shall hold their respective offices until the twenty-third day of February next, and until others shall be chosen in their places.

5. *And be it further enacted*, That the present Constitution of the said Association shall, after passing of this Act, continue to be the Constitution thereof; and that no alteration shall be made therein, unless by a vote to that effect of three-fourths of the resident members, and upon the request in writing of one-third of such resident members, and submitted at least one month before any vote shall be taken thereupon.

State of New York, Secretary's Office.

I CERTIFY the preceding to be a true copy of an original Act of the Legislature of this State, on file in this Office.

ARCH'D CAMPBELL,
Dep. Sec'y.

ALBANY, *April* 29, 1818.

ORDER OF COURT.

ORDER OF THE SUPREME COURT OF THE STATE OF NEW YORK

TO CHANGE THE NAME OF

THE LYCEUM OF NATURAL HISTORY IN THE CITY OF NEW YORK

TO

THE NEW YORK ACADEMY OF SCIENCES.

WHEREAS, in pursuance of the vote and proceedings of this Corporation to change the corporate name thereof from "The Lyceum of Natural History in the City of New York" to "The New York Academy of Sciences," which vote and proceedings appear of record, an application has been made in behalf of said

Corporation to the Supreme Court of the State of New York to legalize and authorize such change, according to the statute in such case provided, by Chittenden & Hubbard, acting as the attorneys of the Corporation, and the said Supreme Court, on the 5th day of January, 1876, made the following order upon such application in the premises, viz:

At a special term of the Supreme Court of the State of New York, held at the Chambers thereof, in the County Court House, in the City of New York, the 5th day of January, 1876:

Present - Hon. Geo. C. Barrett, *Justice.*

In the matter of the application of the Lyceum of Natural History in the City of New York to authorize it to assume the corporate name of the New York Academy of Sciences.

On reading and filing the petition of the Lyceum of Natural History in the City of New York, duly verified by John S. Newberry, the President and chief officer of said Corporation to authorize it to assume the corporate name of The New York Academy of Sciences, duly setting forth the grounds of said application, and on reading and filing the affidavit of Geo. W. Quackenbush, showing that notice of such application had been duly published for six weeks in the State paper, to wit, *The Albany Evening Journal* and the affidavit of David S. Owen, showing that notice of such application had also been duly published in the proper newspaper of the County of New York, in which county said Corporation had its business office, to wit, in *The Daily Register*, by which it appears to my satisfaction that such notice has been so published, and on reading and filing the affidavits of Robert H. Browne and J. S. Newberry, thereunto annexed, by which it appears to my satisfaction that the application is made in pursuance of a resolution of the managers of

said Corporation to that end named, and there appearing to me to be no reasonable objection to said Corporation so changing its name as prayed in said petition: Now on motion of Grosvenor S. Hubbard, of Counsel for Petitioner, it is

Ordered, That the Lyceum of Natural History in the City of New York be and is hereby authorized to assume the corporate name of The New York Academy of Sciences.

Indorsed: Filed January 5, 1876,

A copy.

WM. WALSH, *Clerk*.

Resolution of THE ACADEMY, *accepting the order of the Court, passed February* 21, 1876.

And whereas, The order hath been published as therein required, and all the proceedings necessary to carry out the same have been had, Therefore:

Resolved, That the foregoing order be and the same is hereby accepted and adopted by this Corporation, and that in conformity therewith the corporate name thereof, from and after the adoption of the vote and resolution hereinabove referred to, be and the same is hereby declared to be

THE NEW YORK ACADEMY OF SCIENCES.

THE AMENDED CHARTER.

MARCH 19, 1902.

CHAPTER 181 OF THE LAWS OF 1902.

AN ACT to amend chapter one hundred and ninety-seven of the laws of eighteen hundred and eighteen, entitled "An act to incorporate the Lyceum of Natural History in the City of New York," a Corporation now known as The New York Academy of Sciences and to extend the powers of said Corporation.

(Became a law March 19, 1902, with the approval of the Governor. Passed, three-fifths being present.)

The People of the State of New York, represented in Senate and Assembly, do enact as follows:

SECTION I. The Corporation incorporated by chapter one hundred and ninety-seven of the laws of eighteen hundred and eighteen, entitled "An act to incorporate the Lyceum of Natural History in the City of New York," and formerly known by that name, but now known as The New York Academy of Sciences through change of name pursuant to order made by the supreme court at the city and county of New York, on January fifth, eighteen hundred and seventy-six, is hereby authorized and empowered to raise money for, and to erect and maintain, a building in the city of New York for its use, and in which also at its option other scientific societies may be admitted and have their headquarters upon such terms as said Corporation may make with them, portions of which building may be also rented out by said Corporation for any lawful uses for the purpose of obtaining income for the maintenance of such building and for the promotion of the objects of the Corporation; to establish, own, equip, and administer a public library, and a museum having especial reference to scientific subjects; to publish communications, transactions, scientific works, and periodicals; to give scientific instruction by lectures or otherwise; to encourage the advancement of scientific research and discovery, by gifts of money, prizes, or other assistance thereto. The building, or rooms, of said Corporation in the city of New York used exclusively for library or scientific purposes shall be subject to the provisions and be entitled to the benefits of subdivision seven of section four of chapter nine hundred and eight of the laws of eighteen hundred and ninety-six, as amended.

SECTION II. The said Corporation shall from time to time forever hereafter have power to make, constitute, ordain, and establish such by-laws and regulations as it shall judge proper for the election of its officers; for prescribing their respective functions, and the mode of discharging the same; for the admission of new members; for the government of officers and members thereof; for collecting dues and contributions towards the funds thereof; for regulating the times and places of meeting of said Corporation; for suspending or expelling such members as shall neglect or refuse to comply with the by-laws or regulations, and for managing or directing the affairs or con-

cerns of the said Corporation: and may from time to time alter or modify its constitution, by-laws, rules, and regulations.

SECTION III. The officers of the said Corporation shall consist of a president and two or more vice-presidents, a corresponding secretary, a recording secretary, a treasurer, and such other officers as the Corporation may judge necessary; who shall be chosen in the manner and for the terms prescribed by the constitution of the said Corporation.

SECTION IV. The present constitution of the said Corporation shall, after the passage of this act, continue to be the constitution thereof until amended as herein provided. Such constitution as may be adopted by a vote of not less than three-quarters of such resident members and fellows of the said New York Academy of Sciences as shall be present at a meeting thereof, called by the Recording Secretary for that purpose, within forty days after the passage of this act, by written notice duly mailed, postage prepaid, and addressed to each fellow and resident member at least ten days before such meeting, at his last known place of residence, with street and number when known, which meeting shall be held within three months after the passage of this act, shall be thereafter the constitution of the said New York Academy of Sciences, subject to alteration or amendment in the manner provided by such constitution.

SECTION V. The said Corporation shall have power to consolidate, to unite, to co-operate, or to ally itself with any other society or association in the city of New York organized for the promotion of the knowledge or the study of any science, or of research therein, and for this purpose to receive, hold, and administer real and personal property for the uses of such consolidation, union, co-operation, or alliance subject to such terms and regulations as may be agreed upon with such associations or societies.

SECTION VI. This act shall take effect immediately.

STATE OF NEW YORK,

OFFICE OF THE SECRETARY OF STATE.

I have compared the preceding with the original law on file in this office, and do hereby certify that the same is a correct

transcript therefrom, and the whole of said original law.

Given under my hand and the seal of office of the Secretary of State, at the city of Albany, this eighth day of April, in the year one thousand nine hundred and two.

JOHN T. McDONOUGH,
Secretary of State.

CONSTITUTION.

ADOPTED, APRIL 24, 1902, AND AMENDED AT SUBSEQUENT TIMES.

ARTICLE I. The name of this Corporation shall be The New York Academy of Sciences. Its objects shall be the advancement and diffusion of scientific knowledge, and the center of its activities shall be in the City of New York.

ARTICLE II. The Academy shall consist of five classes of members, namely: Active Members, Fellows, Associate Members, Corresponding Members, and Honorary Members. Active Members shall be the members of the Corporation who live in or near the City of New York, or who, having removed to a distance, desire to retain their connection with the Academy. Fellows shall be chosen from the Active Members in virtue of their scientific attainments. Corresponding and Honorary Members shall be chosen from among the men of science of the world who have attained distinction as investigators. The number of Corresponding Members shall not exceed two hundred, and the number of Honorary Members shall not exceed fifty.

ARTICLE III. None but Fellows and Active Members who have paid their dues up to and including the last fiscal year shall be entitled to vote or to hold office in the Academy.

ARTICLE IV. The officers of the Academy shall be a President, as many Vice-Presidents as there are sections of the Academy, a Corresponding Secretary, a Recording Secretary, a Treasurer, a Librarian, an Editor, six elected Councilors, and one additional Councilor from each allied society or association. The annual election shall be held on the third Monday in December, the officers then chosen to take office at the first meeting in January following.

There shall also be elected at the same time a Finance Committee of three.

ARTICLE V. The officers named in Article IV shall constitute a Council, which shall be the executivie body of the Academy with general control over its affairs, including the power to fill *ad interim* any vacancies that may occur in the offices Past Presidents of the Academy shall be *ex-officio* members of the Council.

ARTICLE VI. Societies organized for the study of any branch of science may become allied with the New York Academy of Sciences by consent of the Council. Members of allied societies may become Active Members of the Academy by paying the Academy's annual fee, but as members of an allied society they shall be Associate Members with the rights and privileges of other Associate Members, except the receipt of its publications Each allied society shall have the right to delegate one of its members, who is also an Active Member of the Academy, to the Council of the Academy, and such delegate shall have all the rights and privileges of other Councilors

ARTICLE VII. The President and Vice-Presidents shall not be eligible to more than one re-election until three years after retiring from office; the Secretaries and Treasurer shall be eligible to re-election without limitation. The President, Vice-presidents, and Secretaries shall be Fellows. The terms of office of elected Councilors shall be three years, and these officers shall be so grouped that two, at least one of whom shall be a Fellow, shall be elected and two retired each year. Councilors shall not be eligible to re-election until after the expiration of one year.

ARTICLE VIII. The election of officers shall be by ballot, and the candidates having the greatest number of votes shall be declared duly elected.

ARTICLE IX. Ten members, the majority of whom shall be Fellows, shall form a quorum at any meeting of the Academy at which business is transacted.

ARTICLE X. The Academy shall establish by-laws, and may amend them from time to time as therein provided.

ARTICLE XI. This constitution may be amended by a vote of not less than three-fourths of the fellows and three-fourths of

the active members present and voting at a regular business meeting of the Academy, provided that such amendment shall be publicly submitted in writing at the preceding business meeting, and provided also that the Recording Secretary shall send a notice of the proposed amendment at least ten days before the meeting, at which a vote shall be taken, to each Fellow and Active Member entitled to vote.

BY-LAWS.

AS ADOPTED, OCTOBER 6, 1902, AND AMENDED AT SUBSEQUENT TIMES.

CHAPTER I.

OFFICERS.

1. *President.* It shall be the duty of the President to preside at the business and special meetings of the Academy; he shall exercise the customary duties of a presiding officer.

2. *Vice-Presidents.* In the absence of the President, the senior Vice-President, in order of Fellowship, shall act as the presiding officer.

3. *Corresponding Secretary.* The Corresponding Secretary shall keep a corrected list of the Honorary and Corresponding Members, their titles and addresses, and shall conduct all correspondence with them. He shall make a report at the Annual Meeting.

4. *Recording Secretary.* The Recording Secretary shall keep the minutes of the Academy proceedings; he shall have charge of all documents belonging to the Academy, and of its corporate seal, which he shall affix and attest as directed by the Council; he shall keep a corrected list of the Active Members and Fellows, and shall send them announcements of the meetings of the Academy; he shall notify all Members and Fellows of their election, and committees of their appointment; he shall give notice to the Treasurer and to the Council of matters requiring their action, and shall bring before the Academy business presented by the Council. He shall make a report at the Annual Meeting.

5. *Treasurer.* The Treasurer shall have charge, under the direction of the Council, of all moneys belonging to the Academy, and of their investment. He shall receive all fees, dues, and contributions to the Academy, and any income that may accrue from property or investment; he shall report to the Council at its last meeting before the Annual Meeting the names of members in arrears; he shall keep the property of the Academy insured, and shall pay all debts against the Academy the discharge of which shall be ordered by the Council. He shall report to the Council from time to time the state of the finances, and at the Annual Meeting shall report to the Academy the receipts and expenditures for the entire year.

6 *Librarian* The Librarian shall have charge of the library, under the general direction of the Library Committee of the Council, and shall conduct all correspondence respecting exchanges of the Academy. He shall make a report on the condition of the library at the Annual Meeting.

7. *Editor.* The Editor shall have charge of the publications of the Academy, under the general direction of the Publication Committee of the Council. He shall make a report on the condition of the publications at the Annual Meeting.

CHAPTER II.

COUNCIL.

1. *Meetings.* The Council shall meet once a month, or at the call of the President. It shall have general charge of the affairs of the Academy.

2. *Quorum.* Five members of the Council shall constitute a quorum.

3. *Officers.* The President, Vice-Presidents, and Recording Secretary of the Academy shall hold the same offices in the Council.

4. *Committees.* The Standing Committees of the Council shall be: (1) an Executive Committee consisting of the President, Treasurer, and Recording Secretary; (2) a Committee on Publications; (3) a Committee on the Library, and such other committees as from time to time shall be authorized by the

Council. The action of these committees shall be subject to revision by the Council.

CHAPTER III.

FINANCE COMMITTEE.

The Finance Committee of the Academy shall audit the Annual Report of the Treasurer, and shall report on financial questions whenever called upon to do so by the Council.

CHAPTER IV.

ELECTIONS.

1. *Active Members.* (*a*) Active Members shall be nominated in writing to the Council by at least two Active Members or Fellows. If approved by the Council, they may be elected at the succeeding business meeting.

(*b*) Any Active Member who, having removed to a distance from the city of New York, shall nevertheless express a desire to retain his connection with the Academy, may be placed by vote of the Council on a list of Non-resident Members. Such members shall relinquish the full privileges and obligations of Active Members. (*Vide* Chapters V and X.)

2. *Associate Members.* Workers in science may be elected to Associate Membership for a period of two years in the manner prescribed for Active Members. They shall not have the power to vote and shall not be eligible to election as Fellows, but may receive the publications. At any time subsequent to their election they may assume the full privileges of Active Members by paying the dues of such Members.

3. *Fellows, Corresponding Members, and Honorary Members.* Nominations for Fellows, Corresponding Members, and Honorary Members may be made in writing either to the Recording Secretary or to the Council at its meeting prior to the Annual Meeting. If approved by the Council, the nominees shall then be balloted for at the Annual Meeting.

4. *Officers.* Nominations for Officers, with the exception of Vice-Presidents, may be sent in writing to the Recording Sec-

retary, with the name of the proposer, at any time not less than thirty days before the Annual Meeting. Each section of the Academy shall nominate a candidate for Vice-President, who, on election, shall be Chairman of the section; the names of such nominees shall be sent to the Recording Secretary properly certified by the sectional secretaries, not less than thirty days before the Annual Meeting. The Council shall then prepare a list which shall be the regular ticket. This list shall be mailed to each Active Member and Fellow at least one week before the Annual Meeting. But any Active Member or Fellow entitled to vote shall be entitled to prepare and vote another ticket.

CHAPTER V.

DUES.

1. *Dues.* The annual dues of Active Members and Fellows shall be $10, payable in advance at the time of the Annual Meeting; but new members elected after May 1 shall pay $5 for the remainder of the fiscal year.

The annual dues of elected Associate Members shall be $3, payable in advance at the time of the Annual Meeting.

Non-resident Members shall be exempt from dues, so long as they shall relinquish the privileges of Active Membership. (*Vide* Chapter X.)

2. *Members in Arrears.* If any Active Member or Fellow whose dues remain unpaid for more than one year, shall neglect or refuse to pay the same within three months after notification by the Treasurer, his name may be erased from the rolls by vote of the Council. Upon payment of his arrears however, such person may be restored to Active Membership or Fellowship by vote of the Cuoncil.

3 *Renewal of Membership.* Any Active Member or Fellow who shall resign because of removal to a distance from the City of New York, or any Non-resident Member, may be restored by vote of the Council to Active Membership or Fellowship at any time upon application.

Chapter VI.

PATRONS, DONORS, AND LIFE MEMBERS.

1. *Patrons.* Any person contributing at one time $1000 to the general funds of the Academy shall be a Patron, and, on election by the Council, shall enjoy all the privileges of Active Members.

2. *Donors.* Any person contributing $50 or more annually to the general funds of the Academy shall be termed a Donor and on election by the Council shall enjoy a'l the privileges of Active Membership.

3. *Life Members.* Any Active Member or Fellow contributing at one time $100 to the general funds of the Academy shall be a Life Member, and shall thereafter be exempt from annual dues.

Chapter VII.

SECTIONS.

1. *Sections.* Sections devoted to special branches of Science may be established or discontinued by the Academy on the recommendation of the Council. The present sections of the Academy are the Section of Astronomy, Physics, and Chemistry, the Section of Biology, the Section of Geology and Mineralogy and the Section of Anthropology and Psychology.

2. *Organization.* Each section of the Academy shall have a Chairman and a Secretary, who shall have charge of the meetings of their Section. The regular election of these officers shall take place at the October or November meeting of the section, the officers then chosen to take office at the first meeting in January following.

3. *Affiliation.* Members of scientific societies affiliated with the Academy, and members of the Scientific Alliance, or men of science introduced by members of the Academy, may attend the meetings and present papers under the general regulations of the Academy.

Chapter VIII.

MEETINGS.

1. *Business Meetings.* Business meetings of the Academy shall be held on the first Monday of each month from October to May inclusive.

2. *Sectional Meetings.* Sectional meetings shall be held on Monday evenings from October to May inclusive, and at such other times as the Council may determine. The sectional meeting shall follow the business meeting when both occur on the same evening.

3. *Annual Meeting.* The Annual Meeting shall be held on the third Monday in December.

4. *Special Meetings.* A special meeting may be called by the Council, provided one week's notice be sent to each Active Member and Fellow, stating the object of such meeting.

Chapter IX.

ORDER OF BUSINESS

1. *Business Meetings.* The following shall be the order of procedure at business meetings:
    1. Minutes of the previous business meeting.
    2. Report of the Council.
    3. Reports of Committees
    4. Elections.
    5. Other business.

2. *Sectional Meetings.* The following shall be the order of procedure at sectional meetings:
    1. Minutes of the preceding meeting of the section.
    2. Presentation and discussion of papers.
    3. Other scientific business.

3. *Annual Meetings.* The following shall be the order of procedure at Annual Meetings:
    1. Annual reports of the Corresponding Secretary, Recording Secretary, Treasurer, Librarian, and Editor.
    2. Election of Honorary Members, Corresponding Members, and Fellows.

3. Election of officers for the ensuing year.
4. Annual address of the retiring President.

CHAPTER X.

PUBLICATIONS.

1. *Publications.* The established publications of the Academy shall be the *Annals* and the *Memoirs.* They shall be issued by the Editor under the supervision of the Committee on Publications.

2. *Distribution.* One copy of all publications shall be sent to each Patron, Life Member, Active Member, and Fellow, *provided,* that upon enquiry by the Editor such Members or Fellows shall signify their desire to receive them.

3. *Publication Fund.* Contributions may be received for the publication fund, and the income thereof shall be applied toward defraying the expenses of the scientific publications of the Academy.

CHAPTER XI.

GENERAL PROVISIONS.

1. *Debts.* No debts shall be incurred on behalf of the Academy unless authorized by the Council.

2. *Bills.* All bills submitted to the Council must be certified as to correctness by the officers incurring them.

3. *Investments.* All the permanent funds of the Academy shall be invested in United States or in New York State securities or in first mortgages on real estate, provided they shall not exceed sixty-five per cent. of the value of the property, or in first mortgage bonds of Corporations which have paid dividends continuously on their common stock for a period not less than five years. All income from patron's fees, life membership fees, and donor's fees shall be added to the permanent fund.

4. *Expulsion, etc.* Any Member or Fellow may be censured, suspended, or expelled, for violation of the Constitution or By-Laws, or for any offence deemed sufficient, by a vote of three-fourths of the Members and three-fourths of the Fellows present

at any business meeting, provided such action shall have been recommended by the Council at a previous business meeting, and also, that one month's notice of such recommendation and of the offence charged shall have been given the Member accused.

5. *Changes in By-Laws.* No alteration shall be made in these By-Laws unless it shall have been submitted publicly in writing at a business meeting, shall have been entered on the Minutes with the names of the Members or Fellows proposing it, and shall be adopted by two-thirds of the Members and Fellows present and voting at a subsequent business meeting.

MEMBERSHIP OF THE NEW YORK ACADEMY OF SCIENCES.

1906.

PATRONS.

Britton, N. L., N. Y. Botanical Garden.
Brown, Addison, 45 West 89th Street.
Casey, Major Thomas L., U. S. A., Washington, D. C.
Chapin, Chester W., 34 West 57th Street.
Field, C. de Peyster, 21 East 26th Street.
Gould, Edwin, Dobbs Ferry, N. Y.
Gould, George J., 195 Broadway.
Gould, Miss Helen M., Irvington, N. Y.
Herrman, Mrs. Esther, 59 West 56th Street.
Julien, Alexis A., Columbia University.
Levison, W. Goold, 1435 Pacific Street, Brooklyn.
Mead, Walter H., 67 Wall Street.
Senff, Charles H., 300 Madison Avenue.
Sloan, Samuel, 26 Exchange Place.

HONORARY MEMBERS.

1887. Agassiz, Alexander. Director of the University Museum, Cambridge, Mass.

1898. Auwers, Arthur. Astronomer and Secretary of the Royal Prussian Academy of Sciences, Berlin, Germany.

1889. Barrois, Charles, Ph.D. Professor of Geology in the University, Rue Pascal 41, Lille, France.

1901. Boys, Charles Vernon, A.R.S.M., F.R.S., 66 Victoria Street S.W., London, England.

1904. Brogger, W. C. Director of the Mineralogical Institute, Christiania, Norway.

1898. Brooks, William K. Henry Walters Professor of Zoölogy, Johns Hopkins University, Baltimore, Md.

1887. Dallinger, Rev. William Henry, D.D., D.Sc., D.C.L., LL.D., F.R.S., Lee, London, S.E., England.

1899. Darwin, Sir George Howard, M.A., K.C.B., F.R.S., Professor of Astronomy and Fellow of Trinity College, Cambridge, England.

1876. Dawkins, W. Boyd. Professor of Geology and Paleontology, Victoria University, Manchester, England.

1904. De Vries, Hugo, Ph.D., Sc.D., LL.D., Professor of Botany in the University of Amsterdam, Amsterdam, Netherlands.

1902. Dewar, Sir James, M.A., LL.D., F.R.S.E., Jacksonian Professor of Experimental Philosophy in the University of Cambridge and Fullerean Professor of Chemistry in the Royal Institute of London, 1 Scroope Terrace, Cambridge, England.

1901. Fischer, Emil. Professor of Chemistry, Hessischestrasse 2, Berlin, Germany.

1876. Geikie, Sir Archibald, F.R.S., Former Director General of Geological Survey of Great Britain and Ireland, Secretary of the Royal Society, 3 Sloane Court, London S.W., England.

1901. Geikie, James, LL.D., D.C.L., F.R.S., F.R.S.E., Murchison Professor of Geology and Mineralogy in the University of Edinburgh, Edinburgh, Scotland.

1889. Gibbs, Wolcott, M.D., LL.D., Professor Emeritus of the Application of Science to the Useful Arts, Harvard University. Address, Newport, R. I.

1898. Gill, David, K.C.B., LL.D., F.R.S. His Majesty's Astronomer, Royal Observatory, Cape of Good Hope, Africa.

1889. Goodale, George Lincoln, M.D., LL.D. Professor of Natural History, Harvard University, Cambridge, Mass.

1894. Haeckel, Ernst, M.D., Ph.D., Sc.D., LL.D. Professor of Zoölogy and Director of the Zoölogical Institute in the University of Jena, Jena, Germany.

1889. Hall, Asaph. Professor of Mathematics, U. S. Navy, (retired), Norfolk, Conn.

1899. Hann, Julius, Ph.D. Professor of Cosmical Physics in the University of Vienna, Vienna, Austria.

1898. Hill, George W., LL.D. West Nyack, N. Y.

1896. HUBRECHT, AMBROSIUS, A. W. Professor of Zoölogy and Comparative Anatomy in the University of Utrecht, Utrecht, Netherlands.

1901. JAMES, WILLIAM, M.D., LL.D. Professor of Philosophy in Harvard University, Cambridge, Mass.

1876. KELVIN, The Right Hon. Lord, D.C.L., F.R.S., O.M., G.C.V.O. President of the Royal Society of Edinburgh. 15 Eaton Place, London, England.

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1906

Fellowship is indicated by an asterisk (*) before the name. Life Membership is shown by heavy-faced type. The names of Patrons are in capitals.

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*Wilson, Prof. E. B.
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Wilson, J. H.
*Wissler, Clark, Ph.D.
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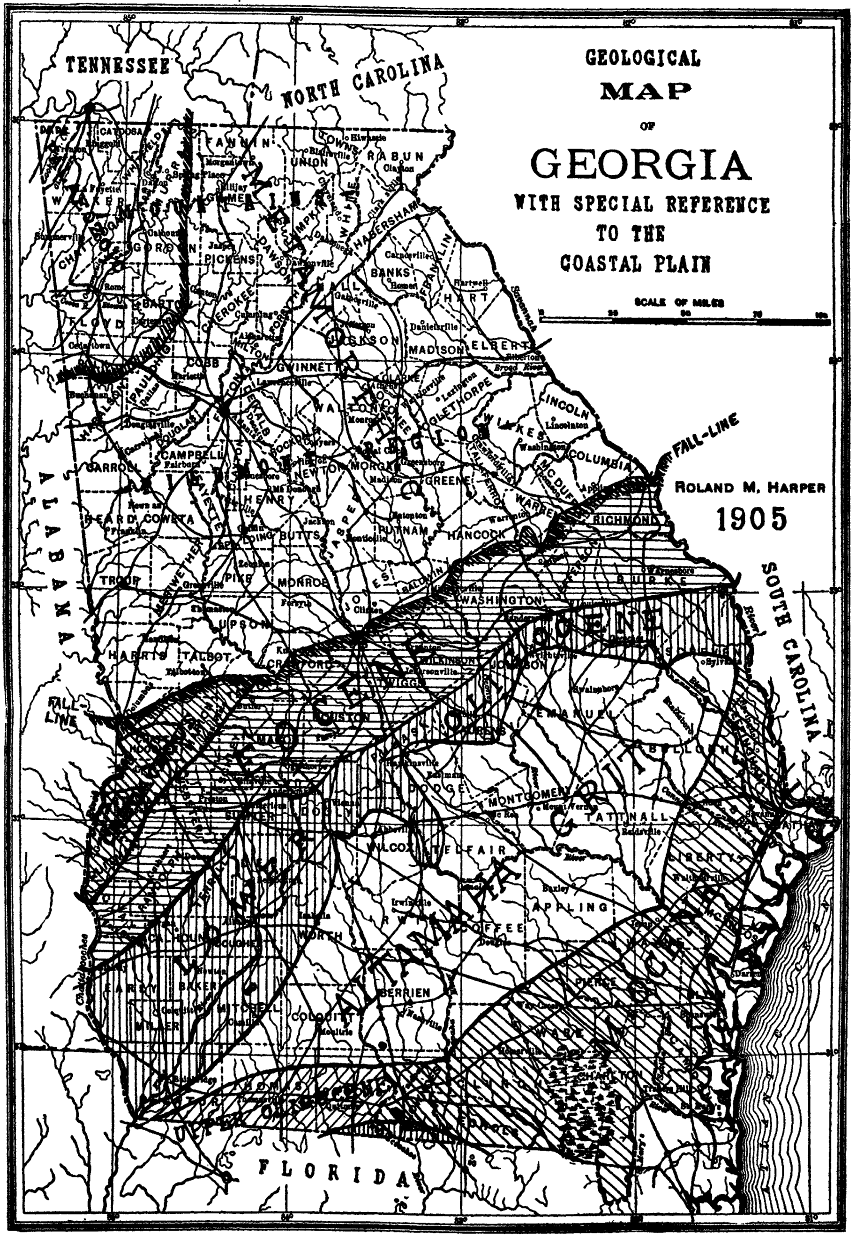
Annals N. Y Acad. Sci., Vol. XVII, Part I, September, 1906.



Map showing geographical relations of the Altamaha Grit region to other parts of Georgia. The fall-line sand-hills, southern lime-sink region and littoral region are not labeled here for lack of space, but they can be readily located by the descriptions given herein. The area labeled Miocene is probably of later age, as indicated in the text. The railroads and county boundaries are shown as they were at the beginning of 1905.

[Annals N. Y. Acad. Sci., Vol. XVII, Part I, pp. 1–415.
September, 1906.]

A PHYTOGEOGRAPHICAL SKETCH OF THE ALTAMAHA GRIT REGION OF THE COASTAL PLAIN OF GEORGIA.

Roland M. Harper.

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INTRODUCTION.

In studying the phytogeography of any region the work can usually be divided into three stages. The first is to determine by observation the geographical distribution and habitat relations of each species, and to distinguish and classify the habitats and their corresponding vegetation. The second is to correlate these observations with measured environmental factors, historical development, and the properties of the plants themselves; or in other words, to ascertain why each plant grows where it does. The third, which is essentially the converse of the second, is to interpret the geological history and geographical phenomena of the region by means of existing vegetation, just as geologists have done by studying the inorganic crust of the earth.

The historical development of phytogeography has proceeded approximately in the order just named. The study of habitats has been traced back to the time of Linnæus, and that of geographical distribution still farther; but even yet in most parts of the world no systematic classification of habitats has been attempted. The foundations of the study of environmental factors were laid by Humboldt a century ago, and at the present time great activity is being manifested in this direction and in the study of historical problems and the adaptations of plants to environment, but much has yet to be learned. In the use of plants to unlock the secrets of geology and geography, which may perhaps be justly regarded as the ultimate object of phytogeography, only the merest beginning has been made, though some good work along this line was done as far back as the middle of the nineteenth century by Gray, Hilgard, and others.

In the present work, which is a study of the vegetation of a small and in many respects homogeneous portion of temperate Eastern North America, the first stage of investigation above defined has been worked out as completely as time and other limitations would allow. In the second and third stages not so much has been done, but some of the more obvious correlations between different sets of phenomena are pointed out, which is always a step in the direction of explaining their causes.

The region is first located with reference to other parts of the world, and its distinguishing characteristics described. The vegetation is then classified, first according to habitat, then taxonomically as in ordinary systematic works, and to some extent according to structure. For each habitat group the environmental factors are indicated as accurately as possible without quantitative measurements, and some attention is paid to development and adaptations, as well as can be done without resort to experimental methods. In the taxonomic classification the local and general geographical distribution and habitat relations of each species are discussed as fully as space and existing knowledge will permit; and throughout the work the geographical significance of the facts observed is kept constantly in mind. The characteristics of the habitats, and the ranges and other attributes of the plants, are summarized at the proper places, by means of diagrams and tables wherever possible, to facilitate comparison. In certain parts of the work some observations are recorded which may seem to have little or no significance at present but will in all probability be explained by future researches, either in this or in other regions.

TEMPERATE EASTERN NORTH AMERICA AND SOME OF THE SYSTEMS WHICH HAVE BEEN USED IN SUBDIVIDING IT.

In discussing the distribution of the plants mentioned in this sketch it will rarely be necessary to go beyond the limits of temperate Eastern North America, a region which may be regarded as one of the primary phytogeographic provinces of the earth, since its flora is mostly endemic. Out of some 6000 known species of vascular plants indigenous to this part of the continent, probably all but a few hundred are confined to it, being hemmed in on all sides by barriers of various kinds. the arctic climate on the north, the tropical climate on the south, the ocean on the east and partly on the south, and the arid region on the west.

For subdividing the flora of temperate Eastern North America on geographical lines several different methods have been employed. Among them are those based on political boundaries, parallels of latitude, altitude, temperature, drainage basins, and geological formations. The first two are probably the most common, but have little natural significance and are used mainly for convenience. Altitude and temperature vary gradually from place to place, so that the boundaries of zones based on these factors are purely arbitrary, except in a few special cases such as the seashore and the frost line. Drainage basins have little to recommend them, from a phytogeographical standpoint, except definiteness of boundaries; but the areas of different geological formations — in temperate Eastern North America but not necessarily in all other parts of the world — seem to answer the purpose best of all, as will be shown below.

The intimate relations between vegetation on the one hand, and soil and topography (which are obviously correlated with geology) on the other, are evident to every observer of geographical phenomena. Certain types of soil and topography are often fairly constant throughout considerable areas, and usually terminate more or less abruptly at their edges, so a classification

of vegetation based on these factors is in many respects ideal. While the same or similar types of soil and topography sometimes occur in connection with different geological formations, yet in that case they are often separated by such distances or barriers that plants cannot readily migrate from one formation to the other, and the floras associated with them are then perceptibly different.

In Georgia, and especially in the coastal plain, where most of the writer's field work has been carried on, similar types of topography and vegetation seem almost invariably to indicate similar geological conditions; and for an area of that size and character a phytogeographical classification based on geology seems to be the only logical one. This may not be equally true everywhere else, but the same principles have been recognized by Hollick on Staten Island and elsewhere in that neighborhood, Gattinger in Tennessee, Smith in Alabama and Florida, and Hilgard in Mississippi, and given prominence in their writings Several other botanists and geologists have noted the intimate relations between botany and geology in a superficial way, but there have been comparatively few attempts in this country as yet to generalize observations of this kind or to explain them.[1]

[1] The following easily overlooked references to this subject, most of them written before "ecology" became popular, and not exhaustive enough to be mentioned in the bibliography at the end of this paper, may be of interest:

Porcher, F. P. *Resources of the Southern Fields and Forests.* xi. 1869.

Flagg, Wilson. *Woods and Byways of New England*, pp. 4, 5, 31, 32. 1872.

Hollick, Arthur. Relations between geological formations and the distribution of plants [on Staten Island, N.Y.]. *Bull. Torrey Club* **7**: 14. 15. Feb., 1880.

Britton. N. L. On the existence of a peculiar flora on the Kittatinny Mountains of northern New Jersey. *Bull. Torrey Club* **11**: 126–128. 1884.

Britton, N. L. Note on the flora of the Kittatinny Mountains. *Bull. Torrey Club*, **14**: 187–189. 1887.

Raymond, R. W. Indicative plants. *Trans. Am. Inst. Mining Engineers*, **15**: 644–660. *f. 1-3.* 1887. Abstract in *Bull. Torrey Club* **14**: 127. 1887.

Evans, H. A. The relation of the flora to the geological formations in Lincoln County, Kentucky. *Bot. Gaz.* **14**: 310–314. 1889.

Coville, F. V. The effect of soil on the distribution of plants. *Rep. Geol. Surv. Ark.*, **1888**[4]: 246-247. 1891

Most of the papers hitherto published on the subject deal only with the more immediate and obvious effects of geology on vegetation, acting mainly through the physical and chemical composition of the soil. The more remote and subtle—but no less important—effects of topography and geological history have not attracted so much attention, but it is one of the purposes of this thesis to discuss some of them for the region under consideration.

GEOLOGICAL DIVISONS.

As the geological divisions of Eastern North America are not often mentioned in botanical literature, a brief outline of them may be of interest.[1] In the order of age, they are as follows:

1. **The Metamorphic region,** with two subdivisions, the Piedmont and the Blue Ridge. The former extends nearly in a straight line from Pennsylvania to eastern central Alabama, in a belt averaging about 100 miles in width. Its underlying rocks are mostly granite and gneiss and its soil a deep red clay. It contains little if any limestone. That portion of the Piedmont region included in Georgia is known as Middle Georgia.[2] It is everywhere hilly, but scarcely mountainous, though a few

Dall, W. H. (Geology of Florida). *Bull. 84, U. S. Geol. Surv.* 95 (near top), 1892.

Small, J. K. Studies in the Botany of the Southeastern United States—I *Bull. Torrey Club,* **21**: 15, 1894. (One reference only.)

Maxon, W. R. On the occurrence of the Hart's Tongue in America. *Fernwort Papers* 30–46. 1900.

Mohr, C. The spontaneous flora of Alabama in its relation to agriculture. *Contr. U. S. Nat. Herb.* **6**: 821–824. 1901.

Macbride, T. H. The Alamogordo Desert *Science* II. **21**: 90–97. Jan. 20, 1905.

[1] For recent maps showing some of these divisions see one by W. M. Davis in Mill's *International Geography,* p. 719, fig. 353, 1900; also fig. 191 in Dodge's *Advanced Geography,* 1905.

[2] For some notes on the flora of a typical portion of Middle Georgia see *Bull. Torrey Club* **27**: 320–341. 1900. The plants of the corresponding portion of Alabama have been enumerated by Prof. Earle in *Bull. 119, Ala. Agric. Exp. Sta*, 1902. The physiography and geology of Middle Georgia are discussed by T. L. Watson in *Bull. Geol. Surv. Ga.* **9A**: 60–65 1902.

isolated peaks (called "monadnocks" by physiographers), of which Stone Mountain[1] is a magnificent example, stand out conspicuously above the rest of the country. The Blue Ridge, extending in its typical development from Pennsylvania to Georgia, borders the Piedmont region on the northwest and includes the highest mountains of Eastern North America. The rocks of this region are chiefly quartzite, sandstone, and marble, and their elevation above the more obdurate granite is explained by the great Appalachian uplift which took place at the end of the Palæozoic period.[2]

The whole Metamorphic region has doubtless been covered with vegetation since Palæozoic or early Cretaceous times; which cannot be said of any other part of Eastern North America. There are many evidences, other than geological, of the great antiquity of this flora, the beginning of which doubtless antedates the appearance of all species of plants now living.

2. **The Palæozoic region.** This is bounded on the southeast by the Blue Ridge. On the north, just beyond the Ohio River, it is overlaid by glacial drift, and on the west it passes beneath the coastal plain. Three divisions of it are distinguished, though not very sharply defined. The Appalachian Valley region is a rather narrow belt extending from Pennsylvania to Central Alabama, and characterized by long narrow parallel ridges with broad level valleys between them. Northwest of that is the Cumberland plateau, with broad table-lands and narrow valleys, and still farther northwest this flattens out into the "barrens" and prairies of Kentucky and adjoining states. The Palæozoic rocks are mostly limestone, sandstone and shale, and the vegetation covering them probably dates from Cretaceous or Tertiary times.

3. **The Coastal Plain.**. This is defined as that part of the North American continent underlaid by Cretaceous and Tertiary rocks and adjacent to the Atlantic and Gulf coasts.[3] It prob-

[1] See *Bull. Torrey Club* **28**: 454, *pl. 29, f. 1.* 1901.

[2] For a recent ecological study of the flora of a typical portion of the Blue Ridge see Harshberger, *Bot. Gaz.* **36**: 241–258, 368–383. 1903.

[3] The formations of the same age in the Great Plains region and west of there have nothing to do with the coastal plain.

ably has no counterpart in any other part of the world. In its typical development it extends from about the mouth of the Hudson River uninterruptedly to the Rio Grande, and up the Mississippi valley to southern Illinois. Most of Long Island, Cape Cod, and the southern islands of New England also belong to the coastal plain, strictly speaking, but as these extreme northeastern portions are mostly covered with glacial drift, and otherwise anomalous, they are not usually treated with the rest. Just what becomes of the coastal plain at its other end, in Mexico, is not definitely known, but it probably does not extend very far into that country. The boundary between the coastal plain and the Piedmont region which adjoins it all along the Atlantic slope is very distinct and unmistakable, as has already been pointed out,[1] and is known as the fall-line.

Practically the whole of the coastal plain is or has been covered with a superficial formation known as the Lafayette, believed to be of Pliocene age, and much of that is in turn overlaid with a Pleistocene formation, the Columbia. The importance of these two formations from a phytogeographical standpoint has been quite generally overlooked. They not only constitute the present soils of the coastal plain, making it difficult to trace the older formations beneath except by their topography, but they also show that the present flora of that region must be of very recent origin, differing greatly in this respect from that of the older regions just mentioned.

4. **Subtropical Florida.** The southern extremity of Florida, including the Everglades and a good deal of contiguous territory, is sometimes regarded as an extension of the coastal plain and sometimes as a distinct province. It is believed to be of Pleistocene age, and is certainly not covered by the superficial formations above mentioned. This alone would be enough to make its soil and flora very different from that of the genuine coastal plain, but it happens also that this is the only part of the Eastern United States free from frost, so it is an open question whether the peculiar flora of this region (said to resemble that of the neighboring Antilles as much as it does

[1] *Bull. Torrey Club* **31**: 10. 1904; *Rhodora* 7: 69. 1905.

that of the rest of the continent) is due more to soil or to climate.

5. **The glaciated region.** The greater part of temperate Eastern North America north of latitude 40° is covered with many feet of glacial drift, obliterating most of the pre-existing geological and topographic features. This is believed to be approximately contemporaneous with or even subsequent to the Columbia formation of the coastal plain. The flora of the glaciated region has several features in common with that of the coastal plain, as the writer has recently pointed out,[1] and this is doubtless due largely to the similarity in age. The older formations are exposed at many points in the glaciated region, however, and this gives a greater diversity to the flora than it would otherwise have.

(A few comparatively small areas of Triassic rocks, located chiefly in New Jersey and North Carolina, have not been mentioned above because they are too limited in extent to have any peculiar flora of their own. They are usually classed with the Piedmont region, which they immediately adjoin.)

Sufficient data are not yet available for estimating with any degree of accuracy the number of indigenous species of plants in the several natural divisions above outlined, and the proportion of species endemic to each. In order to do this the known ranges of all the species would have to be worked out in terms of physiographic divisions, instead of political divisions as has been customary hitherto, and that would require years of study. It is perhaps safe to assume, however, that in the coastal plain, between (but not including) the glaciated portion in the northeast, the subtropical portion in the southeast, and the arid portion in the southwest, there are in the neighborhood of 3000 native species of flowering plants. The number of endemic species assigned to a given region depends largely on the interpretation of specific limits, but the coastal plain probably contains a larger endemic element than any one other division, and perhaps as many endemics as all the rest of temperate Eastern North America combined.

[1] *Rhodora* 7: 69–80. April, 1905.

The conclusion is almost irresistible that nearly all these endemic forms (whether species or groups of higher or lower rank) in the coastal plain must be of very recent origin. For they could not have existed in their present habitats in Pleistocene times, when the coastal plain was nearly all submerged, and if at that time they grew farther inland they have left no trace of the fact. The considerable number of species which are not quite confined to the coastal plain but grow also at a few isolated localities in adjoining regions are perhaps of equally recent origin, though the evidence is not so conclusive in such cases.

The Coastal Plain of Georgia in Particular.

There is no more typical portion of the whole coastal plain than the 35,000 square miles of it included in Georgia, where it constitutes the southern three-fifths of the state. This area (popularly known as South Georgia) is about equally divided between the Atlantic and Gulf slopes. It is equally distant from Long Island and southern New England, where the coastal plain formations are mostly buried beneath the glacial drift, and southern Texas, where the aridity of the climate causes an equally profound modification of the coastal-plain flora.[1] The fact that it is also midway between the highest mountains of Eastern North America, which have presumably been continuously covered with vegetation since before the coastal plain existed, and subtropical Florida, where most of our representatives of tropical species and genera probably first entered this country, has doubtless had a marked influence on the present composition of the vegetation of south Georgia.

Almost all divisions of the coastal plain strata are represented in Georgia, and each is usually recognizable by its characteristic topography and flora. In general the oldest strata come to the surface (disregarding for the present the overlying Lafayette and Columbia formations) farthest inland and at the highest altitude. The strata are believed to have an average seaward slope of 30 or 40 feet to the mile, and their outcropping areas form elongated

[1] See Bray, *U. S. Bureau of Forestry*, Bull. 47: 15, 29. 1904

belts approximately parallel to the coast, as indicated on the map (See frontispiece).

South Georgia contains the following well-marked natural subdivisions.

1. **Fall-line sand-hills.** Extending with some interruptions along the fall-line, not only in Georgia[1] but in the Carolinas[2] and apparently also in Alabama,[3] is a rather narrow belt of sand-hills, standing higher than the rest of the coastal plain on one side and the Piedmont region on the other. (Between the Flint and Chattahoochee rivers the summits of the fall-line sand-hills are nearly if not quite 700 feet above sea-level, being probably the highest part of the coastal plain in the Eastern United States.) The soil of the sand-hills is nearly pure sand, apparently of the Columbia formation (though a much greater age is assigned to it by some geologists). The maximum depth of the sand is unknown, but there is no reason to suppose that it constitutes the whole of the hills from top to bottom. The topography of the sand-hill belt was probably carved out during the Tertiary period, and then during the Pleistocene submergence covered with the mantle of sand which effectually protects the underlying clay or rocks from erosion. It is not yet known why sand-hills of this type are confined to the vicinity of the fall-line, or what relation they bear to the Cretaceous and Eocene rocks. Their flora is very similar to that of the river and creek sand-hills which will be discussed in some of the succeeding pages.

2. **Cretaceous.** The Cretaceous is not very well represented in Georgia, comprising only about 2% of the area of the coastal plain. It is extensive enough to give character to the topography only west of the Flint River. East of there it is found outcropping in some ravines near the fall-line, but cannot very well be shown on a map.

The Cretaceous rocks in Georgia are mostly argillaceous, with some traces of calcium carbonate, and have usually a characteristic gray color. (The Selma Chalk or Rotten Lime-

[1] *Bull. Torrey Club* 31: 10–12. 1904.

[2] *Torreya* 3: 121. 1903.

[3] Smith, *Geol. of the Coastal Plain of Ala.* 349. 1894; Mohr, *Plant Life of Ala.* 96–97. 1901.

stone, which is said to be such a notable feature of the Cretaceous region of Alabama, forming the "black prairies" there,[1] is not known in Georgia.) The topography suggests that of the Appalachian Valley on a reduced scale, the valleys being broader than the ridges, showing that the region has been exposed to erosion a relatively long time.[2] The soils of this region are mostly derived from the Lafayette and Columbia formations, the former being often (perhaps usually) not more than ten feet in thickness, and the latter on top of it still less, or wanting.

3. **Eocene.** The Eocene region is quite extensive in Georgia, reaching entirely across the state and covering about 18% of the coastal plain. Geologists recognize several subdivisions, Midwayan, Chickasawan or Sabine, Claibornian, etc., but these do not differ much from each other in surface features except that the Sabine is usually more level than the rest, and contains a few shallow ponds.

The Eocene rocks in Georgia were probably mostly limestone when first formed, but now those that crop out (except on river bluffs) are usually almost completely silicified, and their hardness gives rise to the most rugged topography in South Georgia. There are many places in the Eocene region where the topography and flora are strikingly similar to those of the Piedmont region a hundred miles farther north. Probably 99% of the Eocene strata are covered by the red loam of the Lafayette formation, often of considerable thickness. The Columbia is not so extensive here as in the Cretaceous region, probably because it has long ago been washed off the steep hillsides, or because the Eocene region stands higher and was not all submerged in the Columbia epoch.

In both the Cretaceous and Eocene regions of Georgia broad-leaved forests predominate, and their aspect is quite like that of the Middle Georgia forests, but they are readily distinguished by the constant presence of a few species confined to the coastal plain, such as *Pinus glabra*, *Dendropogon usneoides*, *Uvularia Floridana*, *Smilax pumila*, *Myrica cerifera*, *Quercus laurifolia*,

[1] See Mohr, *Contr. U. S. Nat. Herb.* 6: 97–105. 1901.

[2] For some notes on its flora see *Bull. Torrey Club* 30: 286–287. 1903.

Magnolia grandiflora, and *Sebastiana ligustrina*.[1] And in almost any river-swamp in the Eocene region we can find *Taxodium distichum*, *Sabal glabra*, *Planera aquatica*, and *Brunnichia cirrhosa*, whose ranges (in Georgia at least) terminate abruptly at the fall-line. Furthermore, on almost every square mile of South Georgia are sandy bogs containing still other species which rarely or never cross the fall-line.

4. **Lower Oligocene.** Next to the Eocene region, and apparently without any sharp demarcation between them, is the area of the Lower Oligocene formations (Jacksonian, Vicksburgian, etc.). Including the Jacksonian (which by many geologists is placed in the Eocene, but from a phytogeographical standpoint seems more closely allied with the Vicksburgian), this division covers about 19% of the area of South Georgia.

The Lower Oligocene rocks are partly soft limestone and partly siliceous. In that part known as the lime-sink region (which is mostly near the Flint River), caves, subterranean streams, large ponds and smaller basin-like depressions are common. Surface streams are rare; one can often travel miles without seeing running water. The topography is comparatively level, with rarely anything that can be called a hill. Practically the whole region, except on steep banks of streams, is covered with the Lafayette and Columbia formations, but the influence of the limestone beneath is sometimes noticeable in the vegetation.

In this region the pine-barrens (*i. e.*, the forests in which *Pinus palustris* is more abundant than all other arborescent species combined, and the trees do not grow thickly enough to sensibly diminish the quantity of light which reaches the ground) begin, and from there to the coast they cover about nine-tenths of the country. The pine-barrens do not begin suddenly, however. At their inland limit the pines are mixed with a considerable quantity of oaks, mostly of two species with broad leaves rusty beneath (*Q. Marylandica* and *Q. digitata*). Toward the coast the quantity of oaks becomes less, and the two species just mentioned are gradually replaced by others with narrower or paler or more glossy leaves (*Q. brevifolia*, *Q. Margaretta*, *Q. Catesbæi*).

[1] See also *Bull. Torrey Club* 31: 15–16. 1904; 32: 453. 1905.

The term "pine-barrens" is not the most appropriate imaginable, and I am not sure that it is ever used in conversation by the present inhabitants of South Georgia, who usually say "piney woods" instead. But the term was undoubtedly used in South Carolina and elsewhere a century or more ago, as is shown by the writings of Catesby, Drayton, Elliott, F. A. Michaux, and others, and it is so common in botanical literature that I have retained it in this work. The name was doubtless given by the early settlers through a misapprehension (owing to the sparsity of trees), as was the case in the "barrens" of Kentucky, about which Prof. Shaler says[1]: "It is an interesting historical fact that the first settlers of the country deemed the untimbered limestone lands of western Kentucky infertile, and therefore gave to them the name of 'barrens.' They were led to the conclusion that these lands were sterile by the fact that in their previous experience the only untimbered lands with which they had come in contact were unsuited to agriculture."

5. **Chattahoochee.** Lying just above the Vicksburgian Oligocene in the geological column, and apparently separated from it by a slight unconformity,[2] is the Chattahoochee formation, the oldest member of the Upper Oligocene series. Its area in Georgia is too small to be shown on the map, but it crops out at the base of the Altamaha Grit (the next division) at several points in Decatur County (particularly near the corner of the state,[3] in a gorge near Faceville,[4] and at the Lime Sink or Forest Falls[5]), also at the "Rock House" (a phenomenon similar to Forest Falls on a smaller scale) about two miles east of Wenona in Dooly County, at Upper Seven

[1] *Ann. Rep. U. S. Geol. Surv.* **12**[1]: 325. 1891.

[2] See Pumpelly, *Am. Jour. Sci.* III. **46**: 445–447. Dec., 1893, Foerste, *Am. Jour. Sci.* III. **48**: 41–54. July, 1894; Vaughan, *Science* II **12**: 873–875. Dec. 7, 1900.

[3] *Bull. Torrey Club* **32**: 149, 150. 1905.

[4] Foerste, *Am. Jour. Sci.* III. **48**: 51–54. 1894; McCallie, *Bull. Geol. Surv. Ga.* **5**: 51. 1896.

[5] *Bull. Torrey Club* **30**: 289–290. 1903. See also the papers by Foerste and McCallie just cited.

Bluffs on the Ocmulgee River (near the mouth of House Creek [1]) in Wilcox County, and probable at corresponding points on the Oconee and Ogeechee rivers. The Chattahoochee formation seems to be rich in plant-food, and wherever it crops out there is a fine growth of angiospermous trees, about which more will be said later.

6. **Altamaha Grit**. The formation with which this sketch is chiefly concerned lies just above the Chattahoochee at several places, and for this reason has been considered next to it in age by some geologists. (It is not known to contain any recognizable fossils, and its age therefore cannot be determined in the usual way.) But on the other hand nothing older than Lafayette has ever been seen above the Grit, and it seems more reasonable to regard the latter as among the more recent formations of the coastal plain, probably as Pliocene. There is every reason to believe that the Altamaha Grit is the equivalent of the Grand Gulf formation of the states farther west,[2] whose age has been equally in doubt,[3] but as the actual continuity of these two formations has not yet been traced it seems best to retain the appropriate and distinctive name Altahama Grit for the present, until it is proved to be a synonym of the earlier (and somewhat misleading) designation, Grand Gulf.

The region in which the unmistakable exposures and characteristic topography of the Altamaha Grit occur corresponds approximately with the middle third of the coastal plain of Georgia. Its inland edge is marked nearly all the way across the state by an escarpment which is one of the notable features of the pine-barren region. In Decatur County the Grit stands 200 feet or so above the soft rocks of the lime-sink region, but east of the Ocmulgee River, where the Lower Oligocene rocks are harder (the lime-sink phase seems to be wanting there), the escarpment is not so conspicuous.

[1] Dall & Harris, *Bull. U. S Geol. Surv.* 84: 81. 1892.

[2] See *Bull. Torrey Club* 32: 144, 145. 1905.

[3] For references to a discussion of this matter see *Bull. Torrey Club* 32: 106 (footnote). 1905.

The topography and flora of this region will be discussed in detail farther on.

7. **Uppermost Oligocene**. Just south of the Altamaha Grit country in Decatur and Thomas Counties, and perhaps also in Brooks and Lowndes, are strata belonging to the Alum Bluff group,[1] which is probably the uppermost member of the Oligocene series in Georgia. It passes southward into Florida, where it is said to be conformably overlaid by Miocene strata toward the Gulf. Its eastern and western limits are not known. The rock of this region is an impure limestone, and the topography is quite rugged, compared with the rest of the coastal plain. In Decatur County (I have not studied it much elsewhere), the soil is almost entirely red loam, presumably Lafayette, and broad-leaved forests (in which *Magnolia grandiflora* is usually conspicuous) predominate, *Pinus palustris* being correspondingly scarce. The whole aspect of the country strongly suggests the Eocene region a hundred miles farther north.[2]

8. **Southern Lime-sink region.** In the southern part of Lowndes County (and probably also in Brooks and Echols and adjacent Florida) is a lime-sink region having much the same character as the Lower Oligocene lime-sink region already mentioned, and containing some of the largest ponds in the state.[3] Geologically this region seems to have Lower Oligocene limestone strata near enough to the surface to exert a decided influence on the topography, but overlaid by a thin layer of Altamaha Grit, and doubtless also by Lafayette and Columbia in most places.

9. **Flat pine-barrens**. Towards the coast the Altamaha Grit region passes gradually into a country so nearly level that there is little distinction between wet and dry pine-barrens, swamps, ponds, and streams (except the rivers). This region includes Okefinokee Swamp, and stretches coastward about to tide-water. It also extends westward at least to Lowndes County, and northeastward and southward beyond the borders of the state. It

[1] According to Vaughan, *Bull. U. S. Geol Surv.* **213:** 392 1903.

[2] For a few additional notes on the Uppermost Oligocene region see *Bull. Torrey Club*, **30:** 289–335 1903.

[3] See *Bull. Torrey Club* **31:** 14, 15, *f.* 3 1904

comprises about 22% of the area of South Georgia, and its average altitude is about 100 feet above sea-level. The Altamaha Grit or some phase of it probably underlies all the flat pine-barrens, but as it is everywhere covered to such a depth with Lafayette and Columbia that no rock outcrops are known, and the topography is appreciably different, it seems best to keep the flat country apart from the typical Altamaha Grit region for the purposes of the present discussion.

Pinus palustris is the prevailing tree in this as in other pine-barren regions, and the whole flora is a good deal like that of the Altamaha Grit region, but probably not so rich, on account of the less diversified topography.

10. **Littoral Region.** Lastly there is the maritime or littoral region, including the islands and marshes along the coast and part of the mainland of the six maritime counties. Little is known of its geology except that the surface is all of the Columbia formation (mostly sand but sometimes clay), or recent alluvium along the rivers, while the Lafayette is either absent or buried out of reach by younger formations.

Pine-barrens are not typical of this region. Sand-dunes, salt and brackish marshes, and dense forests of live-oaks and other angiospermous evergreens are more common. *Sabal Palmetto* is a characteristic tree. The phytogeographical features do not differ conspicuously from those described by Kearney on the coast of North Carolina, Coker in South Carolina, Mohr in Alabama, and Lloyd and Tracy in Mississippi and Louisiana.

THE ALTAMAHA GRIT REGION IN DETAIL.

Location and Boundaries.

Up to 25 years ago the particular region under consideration seems to have been entirely unknown to science. In 1881 Dr. E. W. Hilgard[1] published a geological map of a part of the coastal plain of the southeastern states, showing among other things a few thousand square miles of "Miocene(?) sandstone" in southeastern Georgia, corresponding for the most part with what we now know as the Altamaha Grit region. There is no reference to this area in the accompanying text, but it was probably inserted on the authority of Dr. R. H. Loughridge, who was about that time making a geological and agricultural survey of Georgia for the U. S. Census office. In Dr Loughridge's report, published in 1884 in the 6th volume of the final reports of the Tenth Census, the area of this "sandstone" was mapped in more detail, and some outcrops of it were described. Its geological position was also recognized.

The name Altamaha Grit was given to the formation by Dr. W. H. Dall[2] in 1892, after it had been studied along the Ocmulgee and Altamaha rivers by Mr Frank Burns, of the U. S. Geological Survey. But its boundaries were very imperfectly known, mostly on account of the great scarcity of outcrops, until investigated from a phytogeographical standpoint by the writer in the summer of 1903[3] and spring of 1904. And in the latter year Mr S. W. McCallie of the Geological Survey of Georgia also became interested in it, and discovered some additional outcrops of the characteristic rock, particularly in Johnson County.

Our present knowledge of the areal distribution of this and other geological formations of the coastal plain of Georgia (omitting subdivisions of the Cretaceous and Eocene) is shown on the

[1] *Am. Jour Sci.* III. **22**: *pl.* 3.

[2] Bull. U. S. Geol. Surv. **84**: 81.

[3] See *Bull. Torrey Club* **32**: 141–147. 1905

accompanying map (frontispiece). The Altamaha Grit covers about 11,000 square miles, including parts of twenty counties, midway between the fall-line and the coast. Its inland edge is quite sharply defined, always by a change in topography and a less conspicuous but unmistakable change in flora, and in many places by a bold escarpment besides. Its southern boundary in Decatur and Thomas Counties is pretty well marked by the change from open pine-barrens to the broad-leaved forests of the Uppermost Oligocene region, but toward the southeast it is impossible in the light of present knowledge to say just where the Altamaha Grit terminates or disappears and the flat country begins. This uncertainty makes little difference for the purposes of this work, however, for very few species reach their inland limits in the debatable territory.

Geodetically the Altamaha Grit region (if confined to Georgia), is included between 30° 45′ and 32° 50′ north latitude and 81° 25′ and 84° 50′ west longitude. In altitude above sea-level it ranges from about 400 feet where the escarpment intersects the Atlantic and Gulf divide to 50 or 75 feet on the southeast, and there are consequently no alpine or maritime elements in its flora.

Geology and Soils.

The Altamaha Grit is probably of Pliocene age, as stated above. Outcrops of the characteristic rock are comparatively rare, constituting probably not more than one hundredth of one per cent of the entire area, but they have been seen or heard of by the writer in nearly every county in the region.

The outcrops occur either on hillsides in the open pine-barrens, in beds of streams, or on river-banks. The hillside outcrops show usually a fine-grained conglomerate consisting of small quartz pebbles and grains of sand cemented together with argillaceous material. Chemically it must be composed of silica and alumina, with some iron oxide, but very little if any calcium carbonate. A fresh surface of the Grit (at least the upland phase of it) is yellowish with coarse red mottlings, but it all weathers to a

dull reddish brown, almost exactly the color of pine bark (a very appropriate resemblance, one might say).[1] The rock is not very hard, and can easily be broken up with suitable tools. It finds some use locally for curbing and foundations.

Where it is exposed on river-banks (near Mount Vernon and Lumber City for instance) it has quite a different appearance from the hillside outcrops, being apparently softer and more homogeneous, with a greenish tinge. But many other coastal plain rocks show an equal diversity between their river-bank and upland outcrops.

When thoroughly decomposed by atmospheric agencies the Grit can often hardly be distinguished from the Lafayette loam, and in railroad cuts and other artificial excavations which expose the indurated Grit it is sometimes impossible to say whether there is any Lafayette above it or not.

The Lafayette probably covers more than 99% of the Altamaha Grit region, but its presence cannot easily be proved, for the reason just stated, and also because neither it nor the Grit is fossiliferous. Little if anything is known as to its maximum thickness in this region. In composition it is a loam, containing probably as much sand as clay. Farther inland it is often brick-red, but in the Altamaha Grit region, and in pine-barrens generally, its color is considerably lighter and might be described as terra-cotta.

The Columbia formation is nearly everywhere present, varying in thickness from 25 feet or more in the sand-hills to nothing on rock outcrops and on some of the ridges. It consists of nearly pure sand, probably containing very little plant-food. Where not mixed with humus it is white or very pale buff.

The distinction between the Lafayette and Columbia formations is very familiar to the natives, who know that if they want clay for any purpose they can get it anywhere by digging through a few inches or feet of sand.

Unlike the older parts of the coastal plain, the Altamaha Grit region contains almost no traces of limestone, judging from the nature of the vegetation.

[1] See also *Bull. Torrey Club*, **32**: 144 1905

Topography and Drainage.

The topography of the region under consideration is typically "rolling," and quite pleasing to the eye, in comparison with the flatness which characterizes most pine-barren regions. But there are no jagged outlines, or even steep-sided gullies or ravines as in the older parts of the coastal plain. The ridges rarely culminate in peaks, and the valleys rarely if ever terminate in ponds or depressions. A straight line drawn across the country in any direction (of which the railroads furnish numerous excellent examples), would cross on an average two or three valleys to the mile, each perhaps 20 or 30 feet lower than the intervening ridges. In some places the country is quite flat for several square miles, as may be seen around Collins in Tattnall County, also in the eastern edge of Irwin County near the sources of the Satilla River, and more commonly toward the coastward edge of our territory. Such flat areas seem to be always plateaus, and never valleys, showing that the topography is comparatively young, as we should expect

Ponds are pretty well distributed over the whole region, especially in the flat spots, but they are entirely wanting over hundreds of square miles, particularly in the northernmost counties. As has been noted elsewhere,[1] none of the ordinary ponds are deep enough to retain water throughout the year, and strictly aquatic plants are therefore absent from them. The cause of these numerous ponds is not definitely known The presence of similar depressions in other parts of the coastal plain is often directly traceable to underlying limestone, but the Altamaha Grit region is singularly free from anything of this kind. There are in the region a very few examples (I have seen one near Douglas and heard of another near Statesboro) of "bottomless" ponds, or "lime-sinks" as the natives call them, but they have little in common with the genuine lime-sinks near the Flint River. At the one near Douglas there is nothing in the color of the water or in the nature of the vegetation around its edges to indicate the presence of any calcium carbonate.

In the typical rolling country every little valley contains a

[1] *Bull. Torrey Club* **32**: 146. 1905.

small and often intermittent branch,[1] bordered by more or less swamp.[2] In some cases the very head of a branch is not surrounded by swamp, but is occupied by moisture-loving herbs. Such a place is known as a "dreen."[3] The branches of course unite into larger streams (creeks and rivers) at longer intervals.

A most striking feature of the Altamaha Grit region, and in Georgia mostly confined to it, is the sand-hills, which border the swamps of nearly all the creeks and rivers With few exceptions (such as Rocky Creek in Tattnall County, House Creek in Wilcox, and the Ochlocknee River in Thomas), the sand-hills are all on the left (northeast) sides of the streams to which they belong.

The sand-hills consist merely of homogeneous deposits of Columbia sand, sometimes at least 25 feet deep and over a mile wide, bordering the streams. The fact that they are called hills

[1] The term "branch," as used universally throughout Georgia and doubtless in adjacent states, and to some extent as far north as Maryland and Indiana, is synonymous with "brook" in New England and vicinity. "Branch" in this sense is rarely seen in print, and might be considered by some as a mere provincialism, but the only reason "brook" has the preference is that it happens to be used in the thickly settled parts of the English-speaking world, where more literature to the square mile has been produced than anywhere else Abbot in his *Georgia Insects* (p. 25), published in London in 1797, mentions "rivulets, or *branches*, as they are called in America," and in F. A Michaux's *North American Sylva*, published early in the 19th century, there are frequent references to branch swamps (See for instance under *Gordonia Lasianthus* in the third volume of the original French edition, where he speaks of "les *Branchs swamps*, marais longs et étroits, qui traversent dans toutes sortes de directions les Pinières, *Pines barrens* ")

[2] The word "swamp" is rather loosely defined in the dictionaries. But throughout south Georgia it almost invariably means a wet place full of trees. For the treeless wet places, sometimes called swamps in the North, we already have such words as "marsh," "bog," and "meadow," so there is no good reason why the definition of "swamp" should not be restricted as here indicated. It should be borne in mind that swamps are much more abundant in the coastal plain than in any other part of the United States, so the natives of that part of the country are in a much better position to know exactly what a swamp is than are those who live elsewhere.

[3] A word of local application, doubtless a corruption of "drain," but not exactly synonymous with it.

does not indicate that they are higher than the country on both sides, but merely that they have a decided slope on one side (tôward the stream). They are most delightful places to explore, being free or nearly free from mud, dust, briers, snakes, mosquitoes and other discomforts, and on them the botanist continually encounters pleasant surprises in the way of rare plants. Their continuity lengthwise of the stream is interrupted by occasional tributary streams, but otherwise one may walk for miles on them almost without any trouble.

The origin of these fluvial sand-hills, and the reasons why they are so largely confined to the Altamaha Grit region and to one side of the streams, are as little known as the analogous problems in connection with the fall-line sand-hills. It happens that most of them lie off the main highways of travel, and consequently have been little studied by other persons than the writer. One may travel by the usual routes from Macon to Savannah, Brunswick, Valdosta, or Thomasville, right across the Altamaha Grit region, without seeing a sand-hill. On the two most direct routes from Savannah to Jacksonville, sand-hills are seen only at the Altamaha River, and going from Savannah to Waycross and Bainbridge, a distance of 237 miles, the only sand-hills crossed are those of the Altamaha and Satilla rivers. But from the newer railroads of South Georgia (four or five hundred miles of which have been built since 1900), sand-hills are visible at many points.

There seem to be very few unmistakable allusions to stream sand-hills in literature dealing with other states, so but little idea can be had of their total geographical distribution. The only "sand-hills" mentioned as such in Dr. Mohr's *Plant Life of Alabama* (p. 195) cannot be definitely correlated with those under discussion here, but in Dr. Smith's *Report on the Geology of the Coastal Plain of Alabama* (pp. 56, 57, 84, etc.,) there are brief descriptions of such features, located in parts of the state which Dr. Mohr probably never explored. There are a few meager evidences of the same sort of thing in South Carolina. Elliott,[1]

[1] *Bot. S. C. & Ga.*, 2: 676. 1824. See also *Curt. Bot. Mag*, 54: *pl.* 2758. 1827.

for instance, thus describes a station for *Ceratiola ericoides*: "Near Murphy's Bridge on the Edisto it covers a space of three of four hundred yards in width, and two or three miles long, which appears to have been a sand-bank formed by some of the ancient freshets of that river, and on which only lichens, and a few stunted oaks (*Q. Catesbæi* and *nigra*) are found intermingled with it."

At the base of most sand-hills in our territory is a densely wooded area known as a "hammock."[1] A hammock can scarcely be classed as a topographic feature, however, since it is characterized by its vegetation rather than by topography. The vegetation of hammocks, and of the peculiar intermediate forms known as sand-hammocks, will be discussed at the proper place.

Although the topography in the Altamaha Grit country, as in most other parts of the world, has doubtless been determined almost entirely by erosion, yet there is almost no trace of any erosion going on there at the present time. There are several reasons for this. Before the Columbia period there must have been times when the Lafayette loam which then formed the surface was being worn down quite rapidly in places, giving the topography approximately the form it has to-day. But now the porous Columbia sand allows rain-water to sink into the ground almost immediately without disturbing the surface, while at the same time the impervious Lafayette just beneath protects the underlying rocks from decay. Furthermore, the smaller streams are usually so filled with trees, shrubs, and the humus derived from them that they cannot deepen their channels appreciably. Thus we have a topography of unusual stability. The impotence of erosive forces is shown by the appearance of the streams. The branches, creeks, and rivers rising in this region (and in other parts of the coastal plain covered with the Columbia sands) are rarely or never muddy. The only sediment they carry ordinarily is finely divided vegetable matter, which gives the water a blackish appearance, just as in the rivers of the glaciated region where analogous soil conditions

[1] For a discussion of the orthography, definition, and geographical distribution of this word see *Science* II. **22**: 400–402. Sept. 29, 1905.

prevail.[1] Some of the rivers traversing the Altamaha Grit, such as the Ohoopee and Canoochee, are bordered in places by sand banks evidently of recent alluvial origin, but these do not necessarily indicate that there is much erosion going on at present.

The streams of the Altamaha Grit region may be divided into three classes according to origin, as follows:

1. The rivers which rise north of the fall-line, among the red hills of Middle Georgia, and are consequently always more or less muddy. To this class belong the Ogeechee (which originates such a short distance above the fall-line that it approaches the next class) and the Oconee and Ocmulgee, which unite near the center of the region to form the Altamaha. The Ogeechee is not navigable, but the others are.

2. The rivers and creeks which rise in the Eocene and Lower Oligocene regions of the coastal plain, and are sometimes, but not usually, muddy. To this class belong only the Ohoopee and Little Ocmulgee rivers and some of their tributaries, all finally flowing into the Altamaha. That this class is not more numerous is due to the fact that the Altamaha Grit escarpment is usually so high that not many streams have cut through it, and some of those which do are turned aside until they find a convenient gap. (Note the course of the Ogeechee and Flint rivers in the Lower Oligocene region for instance.)

3. The rivers, creeks, and branches which originate within the Altamaha Grit region, and are rarely if ever muddy. To this class belong the Canoochee, Satilla, Allapaha, Withlacoochee, Little and Ochlocknee rivers, nearly all the creeks, and the innumerable branches.

The significance of this classification of streams will be brought out in discussing the vegetation of the swamps of each. Different streams differ also in the depths to which they have eroded their channels. The Oconee and Ocmulgee rivers have everywhere cut through the Lafayette and Columbia formations and deep

[1] Many persons who have traveled through several degrees of latitude in the Eastern United States hold the erroneous belief that all southern rivers are muddy. But those of Southeast Georgia are just like those of New England, as far as the color of the water is concerned

into the underlying rocks. The Ogeechee in the first class, the rivers in the second class, and some of the rivers and creeks in the third class, seem to have cut through the Lafayette in most places, but perhaps not throughout their length, while the branches and smaller creeks flow over beds of Columbia sand.

CLIMATE.

The following statistics of temperature and rainfall have been compiled by taking the averages of the figures given in the most recent U. S. Weather Bureau reports for fifteen stations in South Georgia in and near the Altamaha Grit region, namely, Albany, Allapaha, Dublin, Fitzgerald, Fleming, Harrison, Hawkinsville, Jesup, Louisville, Millen, Poulan, Quitman, Savannah, Thomasville, and Waycross.

Average mean temperature (in degrees Fahrenheit) and total rainfall (in inches), by months.

Months	Jan.	Feb	Mar	Apr	May	Jun.	Jul	Aug	Sep	Oct.	Nov.	Dec.
Temperature	48 7	49 6	58.4	65.4	73.7	79 6	81.6	80.7	76.1	66.6	56.9	50.1
Rainfall	3 2	5 2	4 7	3.1	3 0	5 3	6.3	6 6	3.9	3.0	2.4	3.5

The same by seasons.

Seasons	Spring (March–May)	Summer (June–Aug.)	Autumn (Sept.–Nov.)	Winter (Dec.–Feb.)	Annual
Temperature	65.8	80.6	66 2	49.5	65.6
Rainfall	10.8	18.2	9.3	11.9	50.3

The averages for the whole of South Georgia would probably correspond very closely with these. It did not seem worth while to give the figures separately for each station, for they do not differ greatly from each other. The lowest average annual temperature included in the above compilations is that of Hawkinsville, 63.6°, and the highest that of Thomasville, 67°. The driest place on the list seems to be Allapaha, with an average rainfall of 46.1 inches, and the wettest Thomasville, with 54.1.

Perhaps the most striking fact in connection with the above

figures is that the summer rainfall is nearly twice as great as that of any other season, and over one-third of the total for the year. This seems to be generally true throughout South Georgia,[1] but not in Middle Georgia [2] and many places farther north.

Snow does not fall in the Altamaha Grit region every year, and the insignificant amount that does fall has so little effect on the vegetation that it may be dismissed from further consideration. Statistics showing the maximum and minimum temperatures, dates of frost, velocity and direction of the wind, humidity, cloudiness, etc., could have been compiled at the expense of considerable time and labor, but they would be of little interest in this connection, since the effects of these factors on the vegetation, in comparison with the mean temperature and rainfall, are not striking.

VEGETATION.

General Considerations.

The Altamaha Grit region is typically a well wooded one. It contains no prairies, lakes, or marshes, and the largest continuous area in it naturally devoid of trees is probably the channel of the Altamaha River, a few hundred feet wide. But while forested throughout, it is typically an unshaded region, for the greater part of the forests consist of pines, which grow far apart [3] and give no shade worth mentioning. Consequently light-loving herbs abound everywhere, and perhaps the most prominent characteristic of the flora as a whole is the prevalence of adaptations for enduring direct sunlight. For this reason the removal of the forest by lumbermen has little effect on the herbaceous vegetation, a state of affairs quite different from that which obtains in the thickly settled and better known parts of the country.

[1] See *Bull. Torrey Club* 27: 414. 1900. (The figures for temperature given there, based on observations made from 1878 to 1884, seem to be a little too high.)

[2] See *Bull. Torrey Club* 27: 321. 1900.

[3] In the pine-barrens the trees average from 20 to 50 feet apart, and from any point an unobstructed view of about a quarter of a mile can usually be had in almost any direction.

Both in dry and wet places, not only in the area under consideration but in other pine-barren regions, we find plants with well-known devices for protection against excessive transpiration, such as reduced, coriaceous, glaucous, or vertical leaves.

From one end of the region to the other, a distance of some 240 miles, the general aspects of soil and topography remain about the same, and we find essentially the same types of vegetation repeated in each county. The slight differences in the composition of the flora of similar habitats in different parts of the region are probably due more to distance than anything else. Differences in climate doubtless have some effect, but probably not as much as distance. It would be hard to find an area of equal extent in the Eastern United States with a more uniformly distributed flora. Probably at least three-fourths of the species known from the whole region may be found in any one of its counties. In view of these facts it seems safe enough to treat the whole region as a unit in most of the discussions which follow.

Causes of Local Diversity.

The factors determining the composition of the vegetation of any particular region or locality are extremely complex. The location of each individual plant in the Altamaha Grit region may be considered as due to the combined influence of some or all the factors enumerated in the following synopsis (which has been designed with special reference to the region here discussed, and is therefore not to be regarded as of universal application).

A Present environment.

- 1. Actinic.
    - Average intensity of light (varying with the nature of the surrounding vegetation, slope of ground, etc.).
    - Range of diurnal variation.
    - Seasonal variations (due to defoliation of deciduous trees, etc).
- 2. Atmospheric (climatic).
    - Temperature.
        - Average, maximum, minimum, etc.
        - Diurnal and seasonal variations.
    - Humidity.
    - Precipitation.
        - Average annual amount.
        - Seasonal variations.
    - Wind.

3. Terrestrial (edaphic).
    - Water.
        - Amount present in soil, or depth if covering the surface.
            - Average.
            - Seasonal variations.
        - Substances held in suspension or solution.
        - Temperature.
        - Movements (especially whether flowing or stationary).
    - Soil and subsoil.
        - Presence or absence of Lafayette.
        - Thickness of Columbia.
        - Alluvium, if any
    - Humus.
4. Organic (biotic).
    - Plants.
        - Equal (associates).
        - Inferior (vines, epiphytes, parasites, etc.).
        - Superior (furnishing nourishment, support, or shade).
    - Animals (man excepted).
        - Beneficial, by
            - Pollination or dissemination.
            - Food for carnivorous plants.
            - Influence on soil and humus.
        - Injurious or destructive.
5. Frequency of fire.

B. Past history. Changes in

1. Environment.
    - Climate.
    - Topography and soil, by
        - Elevation and subsidence.
        - Erosion and sedimentation.
    - Accumulation of humus.
2. Vegetation itself, by
    - Evolution, mutation, hybridization, etc.
        - Rate of variation, and time elapsed.
    - Extinction.
    - Migration.
        - Agencies and routes.
        - Barriers.
        - Time and space.

C. Properties of the species.

- Adaptations to environment.
- Growth and reproduction.
- Dissemination.
- Geographical distribution, past and present.

Some of these factors are essentially the same throughout the region, as is assumed to be the case for instance with climate, which has just been discussed. Those factors which vary in comparatively short distances give the flora whatever diversity it has.

These variable factors depend almost entirely on local conditions of topography and soil, which are indicated for each habitat discussed below. The extent of many of the factors has never been ascertained, while of some others it can only be roughly indicated. Local differences of temperature for instance have not been measured, but these depend mostly on the amount of shade and therefore on the vegetation itself.

Historically the whole flora without exception is believed to have come into the region since the Pleistocene period (which may have been not more than ten or fifteen thousand years ago). Many of the species have probably come into existence since that time, as already suggested, while others which are older have found their way in from more or less distant regions. Little is known about the actual facts of migration in the coastal plain, but the study of ranges throws some light on the subject, and in the discussions which follow the probable origin of some of the habitat- groups is suggested by this means.

Some of the factors under the third head, such as adaptations to environment, are briefly indicated for each habitat-group, but it is not expedient to discuss the properties of each species separately where so many are enumerated and so little space can be given to each. This will be a fruitful field for future investigation, especially since so many of these plants are of such restricted range that they have not yet come to the notice of morphologists. In the taxonomic list will be found references to anatomical studies which have been made of some of the same species elsewhere.

Classification According to Habitat.

A plant-community is generally understood as an association of plants growing in proximity and subject to the same conditions of soil, temperature, moisture, illumination, and other factors which go to make up environment. An assemblage of similar plant-communities, not too widely separated to differ essentially in environment, constitutes a habitat-group.

There are many analogies between habitat-groups and tax-

onomic groups, such as species, though the latter are mutually exclusive categories and the former often are not. For instance, both are capable of being discovered, described, named, and associated with certain type-localities. Records of both may be preserved by descriptions, photographs, measurements, and other means. Both have their diagnostic characters, with more or less variation and intergradation. Both have passed through processes of evolution, are self-perpetuating, and are liable to disappear through geological or climatic changes of the works of man. New ones may also originate, suddenly or gradually. Both have more or less definite geographical distributions and regions of best development. Both are capable of being subdivided, combined, or relegated to synonymy, with the increase of our knowledge concerning them. Habitat-groups, like species, can also be aggregated into larger categories, analogous to genera and families.

In the following pages about twenty different habitat-groups or kinds of plant-communities are described and analyzed. These it is believed will cover something like 99% of the area under consideration. There are several other kinds of plant-communities in the region, but they are rare and as yet imperfectly understood, and it seems scarcely worth while to describe many of them from single examples, without knowing their variations, any more than a new species should be described from a single specimen. Some of them when better known may be described in future editions.

The accompanying map (fig. 1) shows the actual relationships on the ground of twelve of the principal habitat-groups in an imaginary typical portion of the Altamaha Grit region. It is more or less conventionalized and does not pretend to show the relative area of each. The names used will be explained farther on, when the groups are discussed individually. It is quite possible to give technical names to these groups, as well as to plants, as Dr. Clements has shown,[1] but in order to do this new names would have to be coined for most of them, a task which may well be left to future investigators.

[1] See Olsson-Seffer, *Bot. Gaz.*, **39**: 187–193. March, 1905.

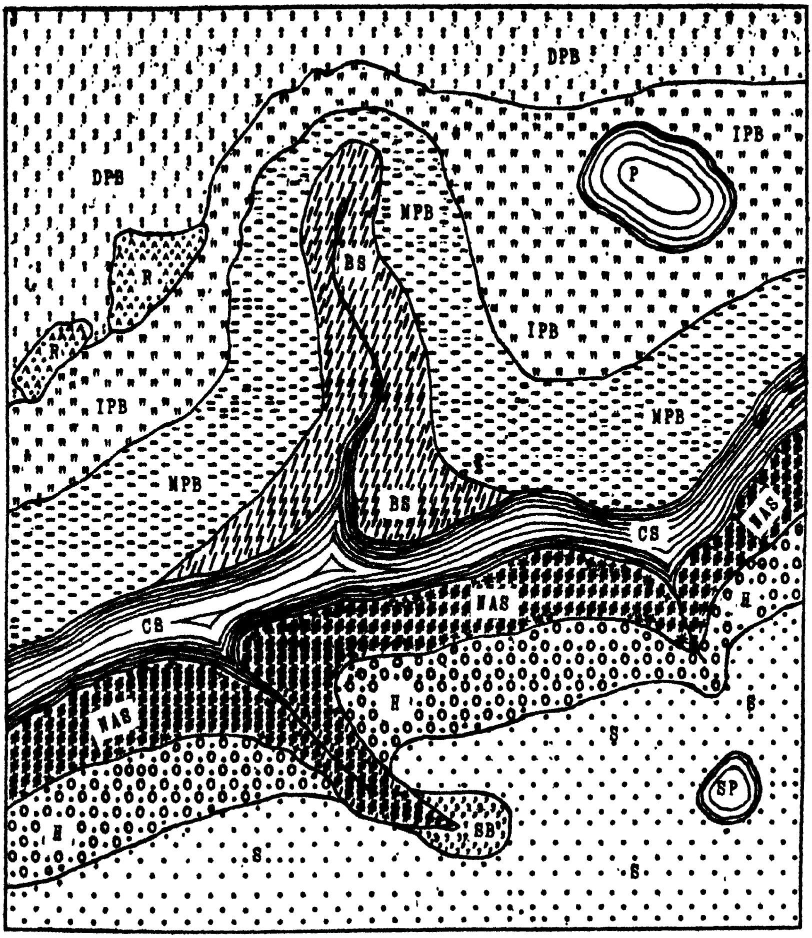

FIG. I.

Map of an imaginary typical portion of the Altamaha Grit region, showing relative situation of twelve of the principal habitats.

R, rock outcrops: DPB, dry pine-barrens; IPB, intermediate pine-barrens; MPB, moist pine-barrens; BS, branch-swamp; CS, creek-swamp; P, cypress pond; S, sand-hills; SP, sand-hill pond; SB, sand-hill bog; H, hammock; NAS, non- alluvial swamp.

Scale about 1 : 5000, or approximately a foot to the mile.

METHOD OF TREATMENT OF HABITAT-GROUPS.

It has been customary with phytogeographers in discussing a group of plants having the same habitat to treat the component species all alike, arranging them in systematic sequence, or alphabetically, or in no definite order. But this gives no adequate idea of their arrangement in nature. In the treatment here adopted I have endeavored by several comparatively simple devices, the application of which will be self-evident after a little explanation, to give the reader (especially if he is acquainted with the species mentioned) as vivid an idea as possible of the actual appearance of each group.

First of all, the species are separated into four classes, corresponding to the four principal strata of vegetation observable in almost any forest, viz., trees, shrubs, vascular herbs, and cellular cryptogams.[1] These are distinguished by their positions with respect to the lateral margins of the page, the names of trees being placed farthest to the left and the others successively farther to the right. These four groups are not always sharply defined in nature, however, and some exceptions have to be allowed for. For instance, a few species, such as *Magnolia glauca* and eight or ten others, are sometimes trees and sometimes shrubs. Again, our two palms, *Sabal* and *Serenoa*, are neither trees, shrubs, nor herbs, but I have classed them arbitrarily with the shrubs. And some species which have an evergreen aërial stem and therefore do not come within the strict definition of herbs, such as *Mitchella*, *Opuntia*, *Smilax pumila*, *Dendropogon*, *Selaginella*, and *Lycopodium*, are classed as herbs on account of their size, and lack of genuine woody tissue. Then I have distinguished evergreens by heavy type,[2] and vines by italics. Annual, biennial, and perennial herbs, not evergreens, are designated by the customary signs, placed immediately after the names. Perennial woody fungi are distinguished by small capitals. Parasites are placed in

[1] The germ of this idea was taken from J. W. Blankinship's paper on the plant formations of Eastern Massachusetts, in *Rhodora* for May, 1903.

[2] In the case of a few species which are partly evergreen the generic name is printed in ordinary and the specific in heavy type.

parentheses and epiphytes in brackets. The following table will illustrate the system:

An evergreen tree.
A deciduous tree.
An evergreen shrub.
A deciduous shrub.
An evergreen woody vine.
A deciduous woody vine.
(An evergreen shrubby parasite.)
An evergreen herb.
[Same, epiphytic.]
A perennial herb, not evergreen ♃.
An annual herb ②.
A biennial herb ②.
A perennial herbaceous vine ♃.
(*A parasitic annual herbaceous vine,*) ①.
A bryophyte, on the ground.
[Same, epiphytic.]
(A PERENNIAL PARASITIC FUNGUS)
A fleshy saprophytic fungus.

This morphological classification is significant in more ways than one. It is obvious that the relation of trees, with their deeply penetrating roots, to the soil is different from that of herbs, especially in the coastal plain where soil and subsoil are often quite unlike, as was ably pointed out by Dr. Hilgard many years ago.[1] The greater size of trees as compared with other plants, and of shrubs as compared with herbs, also subjects them to a greater variety of conditions above ground, and by reason of their greater age (a century or more in the case of some trees), they are subjected to greater variations of climate For the same reason the process of evolution is probably much slower in trees than in annual species, so there may have been a time when the herbaceous flora of the pine-barrens was quite different from what it is now while the arborescent flora was about the same.

It is also obvious that evergreens must stand in a different

[1] *Geology and Agriculture of Mississippi*, pp. 202–204. 1860.

relation to environment from non-evergreens, annuals from perennials, epiphytes from parasites, etc. By the classification here adopted the dominant members of any habitat-group are at once distinguished from those which are more or less dependent, such as vines, epiphytes, and parasites. By making evergreens conspicuous as I have done the difference between winter and summer aspects of each group is shown at a glance. Some striking differences between different habitat-groups are also brought out in this way.

It is interesting to note that all epiphytes and bryophytes (in our territory at least) are evergreen.

Second: keeping the four main classes distinct (for it would not be practicable or fair to compare trees with shrubs, shrubs with herbs, etc.,) the species in each class are arranged as nearly as possible in order of abundance. In all but some of the rarest habitat-groups I have placed before each name a number corresponding to the number of times I have definitely noted that species in that particular habitat. This gives approximately the relative frequence, which in most cases is very nearly the same as the relative abundance. Some phytogeographers in recent years have undertaken to determine relative abundance by actually counting the individual plants on small measured areas of ground. While this method leaves nothing to be desired as far as accuracy is concerned, it would take an incalculable amount of time to apply it to any considerable portion of the region under discussion, and then the final results might not differ much from those obtained by the simple method adopted here. In the case of a few very abundant species I have not taken the trouble to note them in the field as often as some rarer ones, but it is easy enough to place these in their proper places at the head of their respective lists.

Furthermore, after each species, if it is a flowering plant, I have indicated its normal flowering period, as far as known, by figures representing the months. (In the case of the vascular cryptogams these figures are replaced by o.) And if the flowers are entomophilous the predominating color of the corolla (or other organ which serves to attract insects), is indicated. For this purpose

the colors are somewhat generalized, purple including both the common pink-purple of *Rhexia*, *Sabbatia*, and *Gerardia*, and the deep purple of *Vernonia* and related genera. The dark purple, such as occurs in the heads of many Compositæ, is kept distinct, for that probably has a different entomological significance. In the case of anemophilous flowers the color is replaced by a dash. And where a color or time of flowering or other character is not known, or not easily described, it is simply omitted.

If space had permitted it would have been interesting to indicate for each species in these lists its total range, its mode of dissemination, and special adaptations to environment, if known. But these data, when known, have been borne in mind and summarized for each group as far as possible, the same as if they had been printed. It would perhaps have facilitated reference to repeat each list in systematic sequence, so as to contrast the relative abundance, range, and other characters of related species, and to show at a glance the number of representatives of each genus and family, but this would have greatly increased the size of the work.

The names of the species are intended to be the same as in the taxonomic list in the latter part of the work, where author-citations and other bibliographic details will be found. The phænological data are also intended to correspond throughout How these were obtained will be explained at the beginning of the taxonomic list.

The treatment of each habitat-group ends with a partial summation of some of the facts brought out in the lists, together with some of the characters above mentioned which cannot very well be included ın the lists for lack of space. The summation of the times of flowering is accomplished graphically in each case, except where the species are too few in number, by means of a phænological diagram. It would require too much space to explain here the method by which these diagrams are constructed, but they are probably as accurate as the data on which they are based, if not more so. For as the flowering periods are just as likely to be overestimated as underestimated, errors of this kind

tend to counterbalance each other when the statistics are consolidated.

These phænological diagrams are somewhat of an innovation, but their importance will probably be better realized when they come into more general use. They will doubtless afford a valuable means of comparing different habitat-groups in the same region, and similar habitat-groups in different regions. And their application is by no means restricted to habitat-groups, but may be extended to structural and taxonomic groups, such as trees, shrubs, families, genera, etc.

By dividing the area of any phænological diagram by the number of species entering into it the average duration of the flowering period for single species is obtained. Although extreme accuracy could not be expected on account of the present incompleteness of my observations, the figures obtained in this way for different diagrams are remarkably consistent.

Another interesting feature brought out by these diagrams, which might have escaped attention otherwise, is that most of them show a falling-off in the number of species in bloom about the first of May. This is not a peculiarity of the Altamaha Grit region, for I found the same to be true in Middle Georgia in 1896, and I have recently ascertained that in Massachusetts (in some habitats at least) a similar decrease comes about a month later. This falling-off can hardly be correlated with any climatic feature, but it probably indicates that there is a more or less fundamental distinction between spring and summer flowers, connected most likely with the leafing-out of the deciduous trees.

Last but not least, each habitat-group, where practicable, is illustrated by one or more photographs.

It should be borne in mind that Nature draws few hard and fast lines, and the nearest we can get to her methods is only an approximation. I may have drawn the limits of the different habitat-groups too far apart in some cases and too closely in others, but further study will always bring us nearer the truth. By the frequency method above described the typical and characteristic members of each group are placed at the head of the list, while those whose membership is more or less

in doubt come at the foot. Such species as have been noted but once or twice in any particular habitat are usually omitted pending investigation. A species which really belongs in a certain habitat should be observed there repeatedly. Rare plants are not without significance to the phytogeographer, but caution should be used in attempting to draw any conclusions from them.

We are now ready to consider the several habitat-groups individually and in detail. It is not possible to arrange these groups, any more than taxonomic groups, in a space of a single dimension (a linear sequence) and still have each immediately adjoining its nearest relatives. A space of two dimensions would be better, and three dimensions would probably be ideal. A diagram at the end of the detailed discussion shows the relations of the various groups in two dimensions, as accurately as present knowledge will permit.

Species which are believed not to be indigenous are carefully excluded from the habitat lists, and brought together in a single list at the end of the ecological treatment, under the head of weeds.

THE HABITAT-GROUPS.

1. Rock Outcrops.

We may appropriately begin with the hillside outcrops of the Altamaha Grit itself. The nature of these has already been discussed, and the accompanying illustrations (Plate I, Figs 1-2) will give a still clearer idea of their appearance. As already stated, they are quite rare. Their aggregate area probably does not exceed one square mile. The rocks and their surroundings are usually dry, except around their edges or in flat places, where water sometimes collects for a time in wet weather. In the absence of the surrounding pine-barren vegetation they would look very much like some of the granite outcrops in Middle Georgia, except in color.

The plants in the following list have been observed in the counties of Tattnall, Dodge, Wilcox, and Dooly, principally the first mentioned. Although they are arranged as nearly as possible in order of abundance, according to the system above

described, the frequency numbers are omitted, for none of the species has been noted more than four times.

Pinus palustris	3	—
Liquidambar Styraciflua	3	—
Quercus geminata	4	—
Pinus Tæda	3–4	—
Azalea candida	3–4	
Tecoma radicans	5–10	red
Symplocos tinctoria	3–4	cream
Gaylussacia dumosa	4	white
Ilex glabra	4–5	white
Gelsemium sempervirens	3	yellow
Pentstemon dissectus ♃	4–5	purple
Talinum teretifolium ♃	5–9	purple
Crotonopsis linearis ①	8–10	
Sarothra gentianoides ①	6–10	yellow
Ilysanthes refracta	4–7	blue
Chondrophora virgata	9	yellow
Marshallia ramosa	5–6	white
Selaginella arenicola	0	0
Arenaria brevifolia ①	3	white
Polygala Chapmani ①	6	purple
Danthonia sericea	5	—
Polypodium polypodioides	0	0
Afzelia cassioides ①	8–9	yellow
Manfreda Virginica	6–7	cream
Selaginella acanthonota	0	0
Rhynchospora cymosa	5–6	—
Aster squarrosus ♃	11	
Sporobolus Floridanus ♃	9	—
Eryngium yuccifolium ♃	6–7	white
Houstonia longifolia	5–11	purple
Diodia teres	5–10	purple
Krigia Virginica	3–5	yellow
Pteridium ♃	0	0
Cracca Virginiana ♃	4–5	white and purple
Ascyrum pumilum ♃	4–9	yellow
Trichostema lineare ①	8–10	blue
Allium Cuthbertii ♃	5–6	white
Andropogon tener	7–9	—
Yucca filamentosa	5–6	cream
Nolina Georgiana	5	
Amsonia tenuifolia	4–5	pale blue
Utricularia subulata	4–7	yellow
Senecio tomentosus	4	yellow
Rhynchospora plumosa	4–5	—
Grimmia leucophæa		
Thelia asprella		
Frullania Kunzei		
Hedwigia albicans viridis		
Scapania nemorosa		
Ptychomitrium incurvum		
Leucobryum glaucum		

Summary. Vascular herbs are in the majority, as is the case in

most habitat-groups in temperate climates. There are two vines, both woody. Most of the trees and shrubs are evergreen and most of the herbs are not. The herbs are mostly perennial. The trees all have anemophilous flowers, while nearly all the shrubs and herbs are entomophilous. Yellow flowers are most numerous, with white and purple next. The phænological diagram shows that there are about a dozen species in bloom at the same time late in May and early in September, but only about half as many at the end of July. This scarcity of summer

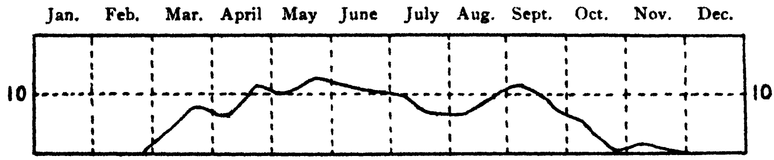

FIG. 2.
Phænological diagram for 40 plants growing on Altamaha Grit outcrops.

flowers is characteristic of many other exposed rocky places,[1] and is due of course to the drying up of the rocks in the summer sun. But this is not so marked in the Altamaha Grit region as elsewhere, because there the extra rainfall in summer tends to counteract the evaporation.

The 40 species of flowering plants represent at least 26 families and 38 genera, pretty well scattered through the whole range of families. But the most striking feature of the whole group is the heterogeneity of their ranges. Two species, *Marshallia ramosa* and *Pentstemon dissectus*, are not definitely known outside of the region, though they are not exclusively confined to rock outcrops. *Azalea candida* I have seen only on or near outcrops of the Grit, but it has been collected by others at two or three stations south of our territory. The remarkably anomalous range of *Chondrophora virgata* has been discussed elsewhere.[2] A considerable number, including *Senecio tomentosus*, *Ilysanthes refracta*, *Crotonopsis*, *Manfreda*, *Arenaria*,[3] *Talinum*, and some of the bryophytes, are more at home on granite outcrops in

[1] See Small, *Bull. Torrey Club*, **24**: 333. 1896; Mohr. *Contr. U. S. Nat. Herb.* **6**: 67, 68, 82. 1901; Gattinger, *Fl. Tenn.* (ed. 2) 22, 23. 1901.

[2] *Bull. Torrey Club*, **32**: 168. 1905.

[3] See *Torreya*, **4**: 138–141. 1904.

Middle Georgia. Others are often weeds, growing in various situations in the southeastern states. The rest are mostly species which have strayed in from the neighboring pine-barrens, hammocks, or sand-hills.

The origin of this rock outcrop flora, particularly the rarer members of it, is a mystery. As rocks of this kind are so few and far apart it is difficult to imagine how some species could have migrated from one rock to another, a hundred miles away, apparently without establishing themselves in intermediate territory. There is no reason for supposing that the total area of these rocks was ever (at least since the coastal plain received its present plant population after the last submergence) greater than it is now. Perhaps the rock-loving plants from farther inland were among the first to take possession of the coastal plain as it emerged from the sea, and have been gradually driven to a last stand on the rocks, to which they were best adapted from previous experience in the Piedmont region. The origin of the three nearly endemic species first mentioned is another problem. The *Marshallia* and *Azalea* do not differ very much from some of their relatives, but the *Pentstemon* is very distinct.

Further study will doubtless tend to elucidate these problems. In the meanwhile we will pass on to the next habitat-group, namely,

2. Dry Pine-Barrens.

The summits and upper slopes of all the ridges (except the sand-hills which will be described later) are covered with dry pine-barrens, which constitute probably at least half the area of the whole Altamaha Grit region. This habitat-group has suffered most from the effects of civilization, for in it are located nearly all the dwellings, farms, and other works of man. Lumbering and turpentining have already destroyed the finest pines, and the fires which sweep over this area every winter and spring do great damage to the young trees. But dry pine-barrens are so abundant that suitable portions of them for study can be found on almost any square mile, and it is easy to allow for the effects of civilization and imagine just what the natural condition of this group should be. (For illustrations see Plate II.)

The surface soil is usually of the Columbia sand, but never too deep for the roots of trees to penetrate it into the Lafayette below. The Lafayette is also so sandy on these ridges, however, that it seems to make little difference to the vegetation whether the Columbia is present or not. Lack of shade is a prominent characteristic of this as well as several of the other habitats.

The following species are characteristic:

∞ **Pinus palustris**	3	—
8 Quercus brevifolia	3	—
7 " Catesbæi	3	—
2 " Marylandica	3	—
1 " digitata	3–4	—
1 " Margaretta	3–4	—
1 Diospyros Virginiana	4–5	white
9 **Gaylussacia dumosa**	4	white
8 **Ceanothus microphyllus**	4–5	white
7 Quercus pumila	3	—
7 Chrysobalanus **oblongifolius**	6	white
7 Asimina angustifolia	5	white
5 **Myrica pumila**		—
4 **Serenoa serrulata**	6	cream
3 Rhus copallina	7–9	cream
3 Castanea alnifolia	5	white
3 Asimina speciosa	4–5	white
2 Amorpha herbacea	6	purple
2 Pieris Mariana	4–5	white
1 *Rubus trivialis*	3–4	white
1 Polycodium cæsium	4	white
1 **Ilex glabra**	4–5	white
1 Ceanothus Americanus	5–6	white
1 Diospyros Virginiana	4–5	white
1 **Vaccinium nitidum**		
2 Elliottia racemosa	6–7	white
1 Cratægus uniflora		white
∞ Aristida stricta ♃	9	—
13 Cracca Virginiana ♃	4–5	white and purple
13 Eriogonum tomentosum ♃	7–9	cream
13 Vernonia angustifolia ♃	7–8	purple
12 Stillingia sylvatica ♃	4–7	yellow
11 Baptisia lanceolata ♃	3–4	yellow
10 Pteridium ♃	0	0
9 Dolicholus simplicifolius ♃	4–9	yellow
11 Helianthus Radula ♃	9–10	dark purple

7 Aster squarrosus ♃	11	
6 **Chrysopsis graminifolia** ♃	8–11	yellow
6 *Breweria humistrata* ♃	5–9	white
6 Stylosanthes biflora ♃	5–7	yellow
5 **Phlox subulata**	3–6	white
5 **Houstonia rotundifolia**	2–4	white
5 **Smilax pumila**	9	cream
5 Psoralea canescens ♃	5–6	blue
5 Laciniaria tenuifolia ♃	8–10	purple
5 *Morongia uncinata* ♃	5–6	purple
4 Calophanes oblongifolia ♃	4–6	blue
4 Crotalaria Purshii ♃	5–6	yellow
5 Polygala incarnata ①	6–9	purple
4 Rhynchospora Grayii ♃	4–6	—
4 Solidago odora ♃	9–10	yellow
4 Euphorbia corollata ♃	4–11	white
4 Ascyrum pumilum ♃	4–9	yellow
3 Baptisia perfoliata ♃	4–6	yellow
3 Sporobolus gracilis ♃	7–9	—
3 Polygala nana ②	4–7	yellow
3 Rudbeckia hirta	5–9	yellow and dark purple
3 Euphorbia gracilis ♃	4–8	dark purple
3 Asclepias cinerea ♃	6–7	gray purple
3 Pterocaulon undulatum ♃	5–6	cream
3 Scutellaria multiglandulosa ♃	5–6	white
3 Angelica dentata ♃	9–10	white
3 Baldwinia uniflora ②	7–9	yellow
3 Anthænantia villosa ♃	8–10	—
3 Kneiffia linearis	4–5	yellow
3 Gerardia setacea ①	9–10	purple
3 Hieracium sp.	9–10	yellow
3 *Meibomia arenicola* ♃	9–10	purple
3 Gerardia filifolia ①	9–10	purple
2 Verbena carnea ♃	4–7	white and pink
2 Galactia erecta ♃	6–7	white
2 Aster adnatus ♃	11	
2 Psoralea Lupinellus ♃	6–7	blue
Asclepias humistrata ♃	4–6	
2 Eupatorium album ♃	7–9	white
2 Gaura Michauxii	7–10	white and pink
2 Berlandiera pumila ♃	4–9	yellow
2 Jatropha stimulosa ♃	4–9	white
2 Asclepias tuberosa ♃	5–9	orange
2 Tragia linearifolia ♃	5–6	
2 Salvia lyrata ♃	4–5	blue

2	Sericocarpus bifoliatus ♃	8–9	white
2	Aletris farinosa ? ♃	5–6	white
2	Buchnera elongata	5–8	purple
2	Trilisa odoratissima ♃	8–9	purple
2	Salvia azurea ♃	9–10	blue or white
2	Cyperus filiculmis ♃	6–7	—
2	Gaillardia lanceolata ①	6–9	yellow and dark purple
2	Andropogon furcatus ♃	7–9	—
2	Coreopsis lanceolata ♃	4–6	yellow
2	Croton argyranthemus ♃	5–8	cream
2	Stenophyllus ciliatifolius ①	7–9	—
1	Manisuris cylindrica ♃	5–6	—
1	Tium apilosum ♃	6	cream
1	Psoralea gracilis ♃	5–6	blue
1	Sorghastrum secundum ♃	9–10	—
1	Hieracium sp. ♃	6	yellow
1	Lupinus villosus ♃	4	
1	Panicum angustifolium ♃	5–6	—
1	*Galactia mollis* ♃	6	purple
1	Scleria glabra ♃		—
1	Tium intonsum ♃	3–4	pale yellow
1	Sabbatia paniculata	6–8	white
1	Polygala grandiflora ♃	6–9	purple
1	Baptisia alba ♃	4–6	white
1	Eryngium synchætum ♃	6–7	white
1	Sorghastrum nutans ♃	9–10	—
1	Phlox amœna ♃	4–6	purple
1	Laciniaria gram nifolia ♃	9–10	purple
1	Trichostema lineare ①	8–10	blue
1	Crotalaria rotundifolia ♃	5–10	yellow
1	Fimbristylis puberula ♃	5–7	—
1	Coreopsis delphinifolia ♃	6–8	yellow
1	Helianthemum Carolinianum	3–4	yellow
1	Polygala polygama ♃	5–7	purple
1	Clitoria Mariana ♃	5–8	blue
1	Ruellia humilis ♃	6	blue
1	Cyperus ovularis ♃	6	—
1	**Yucca filamentosa**	5–6	cream
1	Lygodesmia aphylla	5–7	blue
1	Rhynchospora plumosa ♃	4–6	—
1	Meibomia tenuifolia	9–10	purple
1	Eupatorium tortifolium ♃	8–9	white
1	Silphium Asteriscus angustatum	8	yellow
1	Muhlenbergia expansa ♃	8	—
1	Petalostemon albidus ♃	8–9	white

1 Afzelia pectinata ⓘ	8–9	yellow
1 Dasystoma pectinata ⓘ	8–9	yellow
1 Chamælirium luteum ♃	5	white
1 Laciniaria squarrosa ♃	7	purple
1 Kuhnistera pinnata ♃	9–10	white
1 Chrosperma muscætoxicum ♃	5–6	cream
1 Manfreda Virginica	6–7	cream
1 Galium pilosum ♃		
1 Pentstemon hirsutus ♃	4–6	purple
1 Onosmodium Virginianum ♃	5–6	cream
1 Amsonia ciliata ♃	4–5	pale blue
1 Amsonia tenuifolia ♃	4–5	pale blue
1 Eupatorium compositifolium ♃	10	white
2 Coltricia parvula		

Summary. In the dry pine-barrens herbs are in overwhelming majority, not only in number of species but in individuals, and nearly all of them are perennial. The latter fact was considered by Mr. Nash [1] in the case of the "high pine land" in central peninsular Florida as a protection against destruction by fire, but it might just as well be considered as a protection against drought.

Evergreens are scarce, and mostly confined to shrubs. There are only four or five vines, mostly herbaceous. As already noted, adaptations for reducing transpiration are prevalent. The filiform rigid leaves of the two most abundant plants in the whole region, long-leaf pine and wire-grass, are typical examples.[2] The frequency of such specific names as *angustifolia*, *gracilis*, *graminifolia*, *lanceolata*, *tenuifolia*, and others of similar import is not without significance in this connection.

Flowers seem to be most abundant early in June (see diagram), and at the end of July the number of plants in bloom is scarcely half as large. There is a second but smaller maximum early in September, to which the Compositæ contribute largely. The trees flower early here, as in most other habitats. The average length of the flowering period for a single species is 49 days.

About 24 species in this list have anemophilous flowers, and of those fertilized by insects about 34 are white, 11 cream, 23

[1] *Bull. Torrey Club* **22**: 143, 144. 1895.

[2] For references to anatomical studies of *Baptisia perfoliata*, *Cyperus filiculmis*, and *Pinus palustris* see the catalogue of species.

yellow, 15 purple, and 12 blue. Most of the shrubs have white flowers.

The manner of dissemination is not definitely known for over half the species. Three or four (the *Baptisias* and *Psoralea canescens*) are tumbleweeds. About 23 others, mostly Compositæ, have seeds or fruits transported by the wind. Thirteen, mostly shrubs, have fleshy fruits, adapted to be eaten by birds. Only four or five have barbed fruits. The Cupuliferæ of course have nuts which are supposed to be carried off by squirrels. In perhaps a dozen species the seeds are scattered by elastic force, which is either accumulated in capsules and legumes or actuated by the wind or animals.

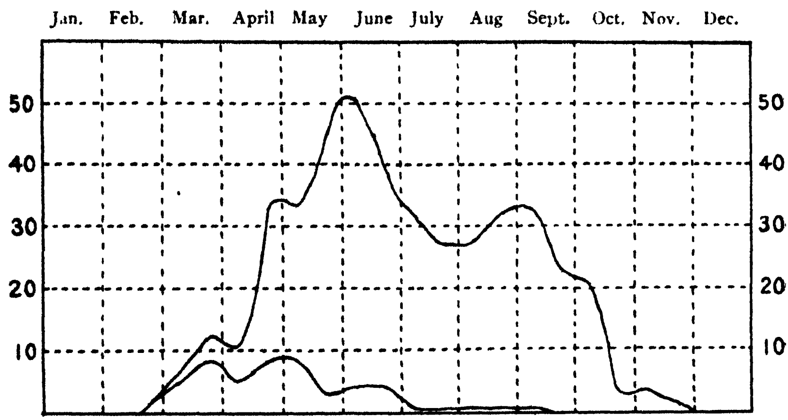

FIG. 3.

Phænological diagram for 131 plants of dry pine-barrens, including 24 trees and shrubs.

The above list contains about 137 species belonging to 100 genera and 38 families. Only 16.4% of the angiosperms are monocotyledons. As in dry sunny places throughout North America, the Compositæ are most largely represented, with 25 species, and Leguminosæ next with 23; but this list contains a larger proportion of the total Leguminosæ of the region than it does of Compositæ. Grasses are not as numerous as one might expect, but one species, *Aristida stricta*, is probably more

abundant than all other herbaceous vegetation combined. Cryptogams are represented only by one fern and one fungus

The ranges of the dry pine-barren plants are quite interesting. None of them are confined to the Altamaha Grit region, or even to Georgia, and not more than two-thirds are confined to the coastal plain. Most of the remaining third are found in dry woods and fields and on southern slopes of mountains in the upper parts of the state,[1] where they are subjected to very similar conditions of soil, light, and heat. Quite a number range still farther north, and are inclined to become weeds in the northern states. Nearly all the dry pine-barren plants grow also in the adjacent Lower Oligocene region of the coastal plain, but not so many descend into the flat country toward the coast. Very few extend southward to the tropics, or even to subtropical Florida; and none of them are native in the Old World.

The highest and driest parts of the pine-barren ridges are often a little sandier than the rest, and contain a larger proportion of oaks, and are known as "oak ridges." The flora of the oak ridges, though approaching that of the sand-hills (to be discussed below) scarcely merits separate recognition, and has all been included in the foregoing list.

3. Intermediate Pine-Barrens.

Descending the slope of any of the innumerable low ridges in the Altamaha Grit country we pass by imperceptible gradations from dry pine-barrens into those which are perpetually moist. Very few species range all the way from dry to moist pine-barrens, however, and between these habitats there is always a transition zone of varying width where species from both meet on common ground. This transition zone, which may be designated as the intermediate pine-barrens, (See Plate III, Fig. 1.) for want of a better name,[2] usually contains in addition some species which are rare or wanting in both adjacent zones, and these therefore entitle it to be considered separately, though its boundaries are often

[1] See *Bull. Torrey Club* **27**: 327, 328. 1900; **30**: 294. 1903; *Torreya*, **5**: 56. April, 1905; also Kearney, *Science*, II. **12**: 830–842. 1900.

[2] In my previous writings I have usually referred to them as rather dry pine-barrens.

extremely vague. In the more level parts of the region the dry pine-barrens become scarcer and the intermediate largely take their place, and in the flat country toward the coast the former almost disappear and the latter doubtless cover more than half the total area.

In the Altamaha Grit region the following species can be definitely assigned to the intermediate pine-barrens.

∞	**Pinus palustris**	3	—
3	" **serotina**	3–4	—
1	" **Elliottii**	2	—
5	**Kalmia hirsuta**	6–9	purple
4	**Serenoa serrulata**	6	cream
4	**Ilex glabra**	4–5	white
4	**Vaccinium nitidum**		
4	Gaylussacia frondosa	4	—
4	**Gaylussacia dumosa**	4	white
3	**Cholisma ferruginea**	5	white
3	Quercus pumila	3	—
3	**Myrica pumila**		—
1	**Hypericum opacum**	7–9	yellow
1	Pieris Mariana	4–5	white
1	Asimina speciosa	4–5	white
1	Castanea alnifolia	5	white
1	**Hypericum myrtifolium**	6–9	yellow
1	Azalea nudiflora	3–4	pink
7	Helianthus Radula ♃	9–10	dark purple
7	Aster squarrosus ♃	11	
5	Pterocaulon undulatum ♃	5–6	cream
5	Trilisa odoratissima ♃	8–9	purple
5	Asclepias cinerea	6–7	gray-purple
2	Aristida spiciformis ♃	7–9	—
4	Rhynchospora ciliaris	5–8	—
4	Sarracenia minor ♃	4–5	yellow
5	Fimbristylis puberula ♃	5–7	
4	Syngonanthus flavidulus ♃	5–9	cream
4	Rhexia Alifanus ♃	6–8	purple
3	Afzelia cassioides ①	8–9	yellow
3	Chondrophora nudata ♃	8–9	yellow
3	Eupatorium rotundifolium ♃	7–9	white
3	Eryngium synchætum ♃	6–7	white
3	Lachnocaulon anceps ♃	4–8	white
3	Aletris lutea ♃	5	yellow
3	" obovata ♃	5	white

3	Baptisia lanceolata ♃	3–4	yellow
3	Thyrsanthema semiflosculare ♃	2–4	cream
3	Kœllia nuda ♃		white
3	Polygala incarnata ①	6–9	purple
3	Xyris flexuosa ♃	7–8	yellow
2	Baldwinia uniflora ②	7–9	yellow
2	Sabbatia Elliottii ①	9–10	white
2	Doellingeria reticulata ♃		white and yellow
2	**Chrysopsis graminifolia** ♃	8–11	yellow
2	Polygala ramosa ②	5–9	yellow
2	Linum Floridanum ♃	6–7	yellow
2	Ascyrum pumilum ♃	4–9	yellow
2	Crotalaria Purshii ♃	5–6	yellow
2	Eupatorium verbenæfolium ♃	8–9	white
2	Trilisa paniculata ♃	8–9	purple
2	Polygala lutea ②	4–9	orange
2	Rhexia ciliosa ♃	6–9	purple
2	Lobelia Nuttallii ②	6–7	blue
2	Cracca hispidula ♃	5–6	
2	Ludwigia virgata	6–9	yellow
2	Cracca Virginiana ♃	4–5	white and purple
2	Euphorbia eriogonoides ♃	5–6	white
2	Muhlenbergia expansa ♃	8	—
2	Carphephorus tomentosus ♃	9	purple
2	Habenaria blephariglottis ♃	8–9	white
2	Polygala setacea ①	5–7	cream
2	Sporobolus Curtissii ♃	8–9	—
1	Psoralea gracilis ♃	5–6	blue
2	Asclepias Michauxii ♃	4–6	gray-purple
1	Rhynchospora Torreyana ♃	6–7	—
1	Polygala Harperi ②	6–8	purple
1	Habenaria nivea ♃	6–7	white
1	Aster adnatus ♃	11	
1	Pteridium ♃	0	0
1	Laciniaria gracilis ♃	10	purple
1	Rudbeckia nitida ♃	6–7	yellow and dark purple
1	Sophronanthe hispida ♃	7–9	white
1	Polygala nana ②	4–6	yellow
1	Salvia lyrata ♃	4–5	blue
1	Rhexia filiformis ♃	6–9	white
1	Juncus biflorus	5–6	—
1	Xyris brevifolia ②	4	yellow
1	Gerardia Skinneriana ①	9–10	purple
1	Sporobolus gracilis ♃	7–9	—
1	Campulosus aromaticus ♃	5–8	—

1 Sporobolus Floridanus ♃	9	—
1 Pinguicula lutea	4	yellow
1 Erigeron vernus ♃	4–8	white and yellow
1 Lupinus villosus ②	4	
1 Ludwigia hirtella	6–8	yellow
1 Vernonia oligophylla ♃	6–7	purple
1 " angustifolia ♃	7–8	purple
1 Piriqueta Caroliniana ♃	6–8	yellow
1 Scleria glabra ♃		—
1 Polygala Chapmani ①	6–7	purple
1 Pinguicula pumila	4–5	pale blue
1 Gerardia aphylla ①	9–10	purple
1 Angelica dentata ♃	9–10	white
1 Bartonia lanceolata	7–10	cream
1 Eupatorium Mohrii ♃	8–9	white
1 Podostigma pedicellata ♃	7–8	yellowish
1 Eleocharis Baldwinii ♃		—

Summary. Perennial herbs predominate here, as in the dry pine-barrens just mentioned. The trees (all of one genus) and most of the shrubs, but few if any of the herbs, are evergreen. There seem to be no vines, epiphytes, parasites, or cellular cryptogams. Biennial herbs seem to be a little more numerous than annual ones.[1]

The number of flowers increases gradually until the beginning of September, and then falls off rapidly. The explanation of

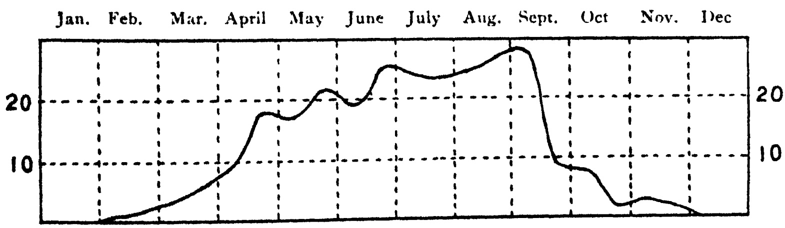

FIG. 4.
Phænological diagram for 92 plants of intermediate pine-barrens.

this is not yet apparent. Each species blooms 45 days, on the average. About 16 species have anemophilous flowers, 18 white, 6 cream, 22 yellow, 14 purple, and 4 blue.

[1] For references to anatomical studies of *Ilex glabra* and *Muhlenbergia expansa* see the catalogue of species.

The manner of dissemination is not definitely known for about half the species. Some 25 species have wind-borne seeds or achenes, about half as many have stiff stems which scatter the seeds short distances by waving in the wind, and some of the shrubs have fleshy fruits. Few if any have fruits adapted for attaching themselves to animals.

The 98 species represent 70 genera and 33 families. The largest family is Compositæ, constituting a fifth of the whole list, but the largest genus is *Polygala*, with seven species. The monocotyledons constitute 22.3% of the total number of angiosperms.

The ranges of these plants are more restricted than those of dry pine-barrens. They are typical coastal plain plants, only about 15 of them being known in other parts of the United States. These 15 are divisible into three classes, namely, those which belong more properly to the dry pine-barrens already discussed, those which are widely distributed in the coastal plain and glaciated region but rare elsewhere, and those which occur in damp sandy places at a few isolated stations in the southern mountains and Piedmont region. Those of the two latter classes belong also to the next habitat group to be discussed.

Within the coastal plain many of the intermediate pine-barren plants do not extend farther inland than the Altamaha Grit region, but nearly all of them grow also in the flat country toward the coast, where similar habitats predominate. Many of them extend well down into Florida, but none reach the tropics, with the possible exception of *Pinus Elliottii*. Less than a third of the number of species range as far north as Virginia, so as to be included in the "Manual region."

4. Moist Pine-Barrens.

The lower slopes of every little valley in the region under consideration are perpetually moist. The explanation of this is simple. The Columbia sand holds water like a sponge, and the Lafayette clay a short distance beneath prevents it from percolating deep into the earth. The sand being a poor conductor of heat protects the water in it from evaporation, so whatever water the soil contains is constantly trickling down the slopes and seeping out at the lower levels.

Although the moist and dry pine-barrens have almost no species in common, their vegetation has much the same aspect, both being equally exposed to light and other factors which come into play above the surface of the ground. See Plate III, Fig. 2, and Plate IV, Fig. 1

Moist pine-barrens probably reach the height of their development in the Altamaha Grit region, and their list of species is a long one, constituting nearly one-fourth of the total flora of the region.

20	**Pinus Elliottii**	2	—
8	Taxodium imbricarium	2–3	—
1	**Pinus serotina**	3–4	—
8	**Ilex glabra**	4–5	white
7	**Hypericum fasciculatum**	4–8	yellow
6	**Myrica Carolinensis**		—
5	Azalea viscosa	6–7	white
5	**Magnola glauca**	4–7	white
4	**Pieris nitida**	3–4	white
4	Liquidambar Styraciflua	3	—
4	Cholisma sp. (888)		white
3	**Kalmia hirsuta**	6–9	purple
3	**Ascyrum stans**	5–9	yellow
2	Styrax pulverulenta	4	white
2	**Hypericum opacum**	7–9	yellow
2	Clethra alnifolia	7–8	white
2	Aronia arbutifolia	3–4	white
2	**Cliftonia monophylla**	3–4	white
1	Pieris Mariana	4–5	white
1	**Hypericum myrtifolium**	6–9	yellow
1	Itea Virginica	4–6	white
1	Gaylussacia frondosa	4	
1	**Gaylussacia dumosa**	4	white
1	***Pieris phillyreifolia***	2	white
41	Sarracenia flava ♃	4	yellow
27	Eriocaulon decangulare ♃	6–9	white
27	Oxypolis filiformis ♃	7–8	white
19	Chondrophora nudata ♃	8–9	yellow
19	Drosera capillaris?	6–8	purple
37	Sarracenia minor ♃	4–5	yellow
20	Eriocaulon lineare ♃	4–5	white
22	Tofieldia racemosa ♃	6–8	white
27	**Sarracenia psittacina**	4	red
22	Syngonanthus flavidulus ♃	5–9	cream

20	Rhexia Alifanus ♃	6–8	purple
24	Baldwinia atropurpurea ②	8–10	yellow and dark purple
20	Juncus trigonocarpus ♃	8–9	—
19	**Chaptalia tomentosa**	2–4	cream
18	Eryngium Ludovicianum ♃	7–10	blue
18	Mesadenia lanceolata virescens ♃	9–10	cream
14	Marshallia graminifolia ♃	7–9	pale purple
12	Fuirena squarrosa hispida ♃	6–9	—
12	**Lycopodium alopecuroides**	0	0
12	Trilisa paniculata ♃	8–9	purple
12	Pogonia ophioglossoides ♃	4–5	purple
11	**Lycopodium pinnatum**	0	0
11	Rhexia lutea ♃	6–7	yellow
11	Rhynchospora Baldwinii	5–7	—
11	Campulosus aromaticus ♃	5–8	—
11	Anthænantia rufa ♃	8–10	—
10	Eupatorium rotundifolium ♃	7–9	white
9	Coreopsis angustifolia ♃	7–9	yellow
10	Xyris Baldwiniana ♃	6–9	yellow
10	Rhynchospora semiplumosa ♃	5–7	—
9	Polygala ramosa ②	5–9	yellow
12	Burmannia capitata ①	8–10	pale blue
9	Scleria trichopoda ♃	7'–9	—
9	Sabbatia macrophylla	7	white
8	" lanceolata	6–7	white
8	Aletris aurea ♃	6–7	yellow
9	**Lycopodium Carolinianum**	0	0
9	Dœllingeria reticulata ♃		white
8	Lophiola aurea ♃	6–7	
8	Sporobolus teretifolius ♃	7–9	—
8	Juncus biflorus ♃	5–6	—
8	Rhynchospora solitaria	5–10	—
8	Eryngium virgatum ♃	8–9	blue
8	Utricularia juncea	7–9	yellow
7	Rhynchospora ciliaris ♃	5–8	—
7	" oligantha	5–6	—
7	Centella repanda	7–8	cream
7	Laciniaria spicata ♃	8–10	purple
7	Erigeron vernus	4–8	white and yellow
7	Ludwigia hirtella	6–8	yellow
6	Mesosphærum radiatum ♃	6–8	
7	Rhynchospora axillaris ♃	5–7	—
6	Pinguicula elatior	3–5	blue
6	Lobelia glandulosa ♃	8–10	blue
6	Leptopoda Helenium	4–5	yellow

6	Baldwinia uniflora ②	7–9	yellow
6	Sagittaria Mohrii ♃	6–9	white
6	Sabbatia campanulata	6–8	purple
6	Lachnocaulon anceps	4–8	white
6	Polygala lutea ②	4–9	yellow
5	Sophronanthe pilosa	6–8	white
5	Afzelia cassioides ①	8–9	yellow
5	Rhexia ciliosa ♃	6–9	purple
5	Polygala cruciata ①	6–9	purple
5	Gerardia aphylla ①	9–10	purple
5	Sisyrinchium Atlanticum ♃	4	blue
7	Drosera filiformis ♃		
7	Oxypolis ternata ♃	11	white
10	Anantherix connivens ♃	7	cream
5	Muhlenbergia sp. (1667) ♃	8–9	—
5	**Mayaca Aubleti**	6–9	pinkish
5	Eleocharis tuberculosa ①	4–6	—
5	Utricularia macrorhyncha	4–9	yellow
5	Pogonia divaricata ♃	5–6	purple
5	Bartonia lanceolata	7–10	cream
4	Rhexia stricta ♃	7–9	purple
4	Coreopsis sp. (1666) ♃	9	yellow
4	Tracyanthus angustifolius ♃	4–5	cream
4	Utricularia subulata	4–7	yellow
4	Carex turgescens ♃	4	—
4	Paspalum Curtisianum	9–10	—
4	Limodorum tuberosum ♃	5–7	purple
4	Proserpinaca (intermediate) ♃		greenish
3	Eupatorium verbenæfolium ♃	8–9	white
3	Rudbeckia Mohrii ♃	6–9	yellow and dark purple
3	Dichromena latifolia ♃	5–7	white
3	Rhynchospora gracilenta	6–7	—
3	Gerardia paupercula ①	9–10	purple
3	Andropogon Tracyi ? ♃	9–10	—
3	Rhynchospora rariflora	5–6	—
3	Habenaria ciliaris ♃	7–8	orange
3	Rhynchospora alba macra ♃	9–10	white
3	Anchistea Virginica ♃	o	o
3	Helianthus angustifolius ♃	9–10	yellow
3	Manisuris rugosa ♃	8–9	—
3	Xyris fimbriata ♃	7–9	yellow
3	Utricularia cornuta	5–7	yellow
2	Pinguicula lutea	4	yellow
3	Fimbristylis puberula ♃	5–7	—
2	" autumnalis ①	6–9	—

2	Habenaria integra ♃	8	yellow
2	Helianthus undulatus ♃	9–10	yellow
2	Kœllia nuda ♃		
2	Scleria hirtella ♃	8	—
2	(*Cuscuta indecora*) ①	9	cream
2	Eleocharis bicolor ①	9	—
2	Rhynchospora Torreyana	6–7	—
2	Rudbeckia nitida ♃	6–7	yellow **and dark purple**
2	Ludwigia linearis	8–9	yellow
2	Rhynchospora Chapmani ♃	7–8	—
2	**Juncus polycephalus**	4–6	—
2	Asclepias lanceolata ♃	6–8	red
2	Scleria verticillata ♃	8	—
1	Andropogon Mohrii ♃	9–10	—
1	“ corymbosus ♃	9–10	—
1	Carphephorus Pseudo-Liatris ♃	9–10	purple
3	Sarracenia flava × minor ♃		
2	Panicum verrucosum	9	—
2	Rhexia filiformis ♃	6–9	white
2	Eryngium synchætum ♃	6–7	white
2	Cyperus Haspan ♃	6–8	—
2	Osmunda cinnamomea ♃	0	0
1	Oxytria crocea ♃	5	yellow
1	Physostegia denticulata ♃	6–7	purple
1	Habenaria nivea ♃	6–7	white
1	Paspalum præcox	6	—
1	Xyris platylepis ♃	8	yellow
1	Carduus LeContei	7	—
1	Melanthium Virginicum ♃	6–7	white
2	Rhynchospora inexpansa	5–6	—
2	Eleocharis melanocarpa ♃	4–7	—
2	Limodorum graminifolium ♃	5–6	purple
1	Gerardia linifolia ♃	8–9	purple
1	Fuirena breviseta ♃	7–9	—
1	Gerardia purpurea ①	9–10	purple
1	Lycopus pubens ♃	9–10	white
1	Ludwigia pilosa	6–9	
2	Scleria gracilis ♃	5–7	—
2	Sarracenia rubra ♃	4	red
1	Pinguicula pumila	4–5	pale blue
1	Aletris lutea ♃	5	yellow
1	Arundinaria tecta ♃	5	—
1	Xyris neglecta	7	yellow
1	Panicum Combsii ♃	9	—
1	Gerardia Skinneriana ①	9–10	purple

1	Cynoctonum sessilifolium	7–8	white
1	Juncus scirpoides ♃		—
1	Panicum melicarium	5–7	—
1	Xyris flexuosa ♃	7–8	yellow
1	Linum Floridanum ♃	6–7	yellow
1	Aster eryngiifolius ♃	7	
1	Habenaria cristata ♃	7–8	yellow
1	" blephariglottis ♃	8–9	white
1	Lilium Catesbæi ♃	8–9	red
1	Iris versicolor ♃	4–5	blue
1	Polygala cymosa ②	5–9	yellow
1	Tridens ambiguus	6–8	—
1	Stokesia lævis ♃		
1	Rhynchospora compressa	5	—
1	Sarracenia minor × psittacina ♃		
1	Kœllia hyssopifolia ♃		
1	Eryngium yuccifolium ♃	6–7	white
1	Panicum hemitomon ♃	6	—

Summary. The woody plants (most of them evergreen) are greatly outnumbered by the herbs, not only in species, but still more in individuals. The trees are all conifers. The shrubs, which are most abundant on the lower slopes, and almost wanting higher up, are mostly rather small and scattered. It is interesting to note that two species which become large trees in some other parts of South Georgia, namely *Liquidambar* and *Magnolia glauca*, are only shrubs in moist pine-barrens. The *Magnolia* fruits abundantly when only knee-high, but I have not yet discovered how the shrubby *Liquidambar* reproduces itself.

The herbs are mostly perennials, as in the groups previously discussed. Few of them are evergreen, but many have not been studied enough in winter to determine certainly whether they are evergreen or not. *Pieris phillyreifolia* is the only woody vine (if it can be called a vine),[1] and *Cuscuta indecora* is the only herbaceous vine, and at the same time the only parasite. There seem to be no epiphytes or cellular cryptogams. Most of the species have narrow leaves, or other adaptations for reducing transpiration, just as in the dry pine-barrens.[2]

[1] See *Torreya* 3: 21–22, Feb. 1903.

[2] For references to anatomical studies of *Oxypolis filiformis*, *Ilex*

The number of species in bloom at once is greatest early in July, and nearly as great in August and September, but considerably less at other times. The average flowering period is 49 days, just as in the dry pine-barrens. Over 50 species have anemophilous flowers, about 35 white,[1] 35 yellow, 20 purple, 8 cream, 7 blue, and 4 red. Why white, yellow, and purple flowers are so predominant here (and in other pine-barren regions)[2] is a problem for the entomologist. The

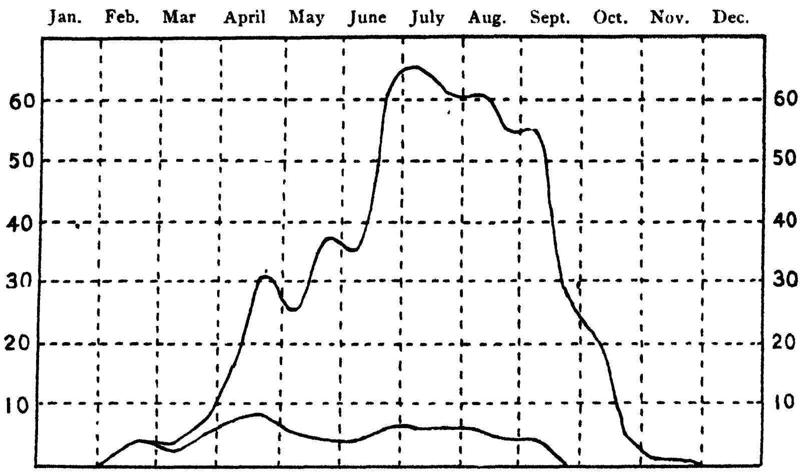

FIG. 5.
Phænological diagram for 172 plants of moist pine-barrens, including 22 trees and shrubs.

abundance of these flowers, and the large size of many of them, together with the omnipresent bright yellow leaves of *Sarracenia flava*, make the moist pine-barrens very beautiful in summer.

glabra, *Myrica Carolinensis*, and *Eriocaulon decangulare*, see catalogue of species. Note the frequency in this habitat-group of such specific names as *angustifolia*, *filiformis*, *graminifolia*, *linearis*, and *nitida*.

[1] One of the white-flowered species, *Dichromena latifolia*, belongs to a family in which anemophily prevails (Cyperaceæ.) Although I have never observed the visits of insects to this plant, there can be little doubt that its very conspicuous snow-white bracts are for the purpose of attracting them.

[2] See *Bull. Torrey Club*. 27: 424. 1900.

The commonest method of dissemination seems to be by smooth seeds contained in erect capsules, calyces, or honeycomb-like receptacles opening at the top and borne on stiff erect stems which persist through the winter. When such a stem is bent suddenly to one side the seeds are discharged by centrifugal force. Good examples of this (called by Dr. Clements tonoboles[1]) are seen in 40 or 50 species, belonging to *Baldwinia, Gerardia, Mesosphærum, Sabbatia, Ludwigia, Rhexia, Hypericum, Linum, Sisyrinchium, Lilium, Juncus, Xyris*, and doubtless several other genera. About 25 species have wind-borne seeds or achenes, and a few of the shrubs have fleshy fruit. Adhesive fruits seem to be entirely wanting,[2] unless the achenes of the *Rhynchosporas* with their barbed bristles function in this manner. The plants of this habitat-group evidently do not depend much on animals to carry their seeds.

The list contains 187 species in 105 genera and about 46 families. The largest family is Cyperaceæ, with 27 species. Compositæ is a close second, with 24, and Gramineæ third, with 16. *Rhynchospora* is the largest genus in moist pine-barrens (as well as in the whole Altamaha Grit region), with 13 species. No other genus has half as many. The total absence of the Euphorbiaceæ and Leguminosæ, and of all families between Magnoliaceæ and Myricaceæ, is noteworthy. Over two-fifths of the whole list (43.6% of the angiosperms) are monocotyledons. This accords with the common belief among botanists that plants growing in wet places are as a rule not as highly organized as others. Although no forms of vegetation below the ferns have been observed in these moist pine-barrens, it is altogether probable that some species of *Sphagnum* could be found, and perhaps also some of the minute parasitic fungi.

The plants of this group do not seem to be quite so restricted in range as those in the intermediate pine-barrens. About 60 species, or nearly a third, are confined to the pine-barrens of the southeastern states, while an equal number reach their northern limits in the coastal plain somewhere between New

1 *Bot. Surv. Neb.*, 7: 47. 1904.

2 Compare this with a statement in *Bull. Torrey Club*, 31: 16. 1904.

York and Virginia. About 20 species are confined to the coastal plain of the southeastern states, but not to the pine-barrens. Half a dozen or so are not known outside of Georgia. About 25 species extend inland to sandy bogs in Middle Georgia and the neighboring mountains, and fifteen or twenty have a wide distribution in similar habitats in the glaciated region of the north.[1] Ten others grow almost anywhere in the Eastern United States. About 15 are supposed to range southward to tropical America. This is rather anomalous, for there can be no Lafayette and Columbia formations in the tropics; and doubtless some of our plants will hereafter be found to be specifically distinct from their tropical allies.

5. Branch-Swamps.

If we start at the head of any little valley in the Altamaha Grit region and go down-hill, we come in a very short distance, after passing through dry, intermediate and moist pine-barrens, to a branch-swamp occupying the trough of the valley. A branch-swamp, like any other swamp,[2] is characterized by the predominance of trees and shrubs, presenting a marked contrast to the pine-barrens immediately adjoining. The difference in vegetation is not to be explained by differences in the amount of water in the soil, for branch-swamps are not much if any wetter than the moist pine-barrens, and trees and shrubs are by no means confined to wet places. The explanation is doubtless to be found in the humus which the swamps contain. What little humus is formed in the pine-barrens of course tends to accumulate at the bottom of the valleys, and gradually prepares the soil for the growth of broad-leaved woody plants. These plants as they arrive naturally produce more humus, and there is every reason to believe that the branch-swamps are tending to increase their area in this way, independently of topographic or climatic changes, though the process is probably so slow that it would not be perceptible in a single life-time. The trees and shrubs are of course accompanied by herbs which thrive in

[1] See *Rhodora* 7: 69–80. April, 1905.

[2] See footnote on page 21.

their shade in preference to the bright sunlight of the open pine-barrens. Here we doubtless have an example of that succession of vegetation which has been so ably worked out by Dr. Cowles in the vicinity of Chicago and elsewhere.

All branch-swamps are not alike; some contain a great many more bushes than others. The densest of these swamps seem to be where the Columbia sand is deepest, probably because where it is thin the water runs off the adjacent slopes faster and does not favor the accumulation of humus. Illustrations of the open and dense types are subjoined (Plate IV, Fig. 2, and plate V).

As there are all possible gradations between open and dense branch-swamps, they are all combined in the following list of characteristic species.

3 **Pinus Elliottii**	2	—
11 Nyssa biflora		
2 Taxodium imbricarium	2–3	—
9 **Magnolia glauca**	4–7	white
7 **Pinus serotina**	3–4	—
5 Liriodendron Tulipifera	4	cream
5 Acer rubrum	2	red
1 **Persea pubescens**		
1 **Gordonia Lasianthus**	7–9	white
11 Pinckneya pubens	6–7	pink
10 Viburnum nudum		white
7 Nyssa Ogeche	4–5	
5 Clethra alnifolia	7–8	white
5 Cyrilla **racemiflora**	6–7	white
5 Rhus Vernix		cream
4 **Pieris nitida**	3–4	white
3 **Cliftonia monophylla**	3–4	white
1 **Hypericum fasciculatum**	4–8	yellow
2 Aronia arbutifolia	3–4	white
2 **Ilex glabra**	4–5	white
2 **Viburnum nitidum**	4	white
2 Leucothoè racemosa	4	white
1 **Ilex myrtifolia**		
1 ***Smilax laurifolia***		cream
1 **(Phoradendron flavescens)**		green
1 Alnus rugosa	1–2	—
1 *Wistaria frutescens*	4	blue
1 *Rhus radicans*	5	cream
4 Sabbatia foliosa ♃	6–8	purple

4	Lorinseria areolata ♃	o	o
3	Ludwigia pilosa ♃	6–9	
3	Iris versicolor ♃	4–5	blue
3	Macranthera fuchsioides ♃	9–10	orange
2	Rhynchospora axillaris ♃	5–7	—
2	Panicum scabriusculum	6	—
2	**Juncus polycephalus**	4–6	—
2	Centella repanda ♃	7–8	cream
2	Gratiola ramosa	6–7	cream
2	(*Cuscuta compacta*) ①	9	cream
2	Osmunda cinnamomea ♃	o	o
2	Carex glaucescens ♃	6–7	—
2	Sarracenia flava ♃	4	yellow
2	Eriocaulon lineare ♃	4–5	white
2	" decangulare ♃	6–9	white
2	**Isoetes flaccida**	o	o
1	Cyperus Haspan ♃	6-8	—
1	Anchistea Virginica ♃	o	o
1	Xyris sp. (1574)	8–9	yellow
1	Mesosphærum radiatum ♃	6–8	
1	Oxypolis rigidior ♃	9–11	white
1	Kœllia hyssopifolia ♃		
1	Carex turgescens ♃	4	—
1	Polygala cymosa ②	5–9	yellow
1	Sagittaria Mohrii ♃	6–9	white
1	Pluchea imbricata ♃	6–9	
1	Juncus Elliottii ♃	5–6	—
1	Physostegia denticulata ♃	6–7	purple
1	Gerardia linifolia ♃	8–9	purple
1	Rhynchospora glomerata paniculata ♃	6–8	—
1	Panicum lucidum	6	—
1	Manisuris rugosa ♃	8–9	—
1	Erigeron vernus ♃	4–8	white and yellow
1	Rudbeckia Mohrii ♃	6–9	yellow and dark purple
1	Eupatorium perfoliatum ♃	9	white
1	*Apios tuberosa* ♃	8	dark purple
1	Coreopsis nudata ♃	4–6	purple
1	Asclepias lanceolata ♃	6–8	red
1	Ilysanthes refracta ① or ②	4–7	blue
1	Sporobolus Floridanus ♃	9	—
1	Sarracenia minor ♃	4–5	yellow
1	Proserpinaca palustris ♃	6–8	greenish
1	" (intermediate) ♃		greenish
1	" pectinata ♃		greenish

1 Scleria trichopoda ♃	7–9	—
1 Xyris ambigua ♃	6	yellow
1 *Clematis crispa* ♃	4–9	pale blue
1 Rhynchospora inexpansa	5–6	—
1 Oxytria crocea ♃	5	yellow
1 Sphagnum macrophyllum		
1 Pallavicinia Lyellii		
1 Odontoschisma prostratum		
1 Lycogala epidendrum		

Summary. Trees and shrubs here form the bulk of the vegetation, the herbs, though more numerous in species, being relatively scarce and inconspicuous. About half of the woody plants are evergreen. The herbs are mostly perennial, as usual. There are 6 vines, 3 of them woody and 3 herbaceous, and two parasites, one a shrub and one an herb.[1]

Flowers seem to be most numerous in midsummer, but if trees and shrubs alone were considered spring flowers would pre-

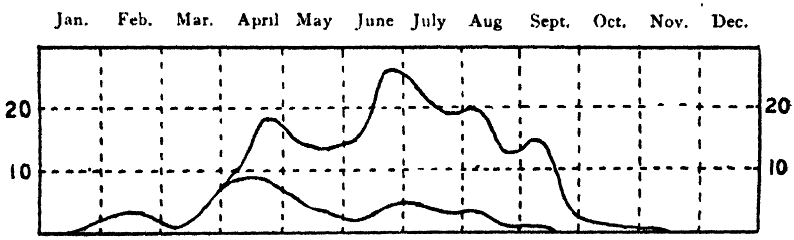

FIG. 6.

Phænological diagram for 66 plants of branch-swamps, including 21 trees and shrubs.

dominate. The phænological diagram is very similar to that for moist pine-barrens, making allowance for the much smaller number of species involved. The average flowering period too, is nearly the same, 48 days. None of the herbs seem to bloom before April.

There are about 15 anemophilous species in the list, and the same number with white flowers. Other colors are less abundant, and there are not many conspicuous flowers in the whole lot. Probably the most conspicuous are those of *Pinckneya*, which are

[1] For references to anatomical studies of *Ilex glabra Aronia arbutifolia*, and *Magnolia glauca* see the catalogue.

unique in that the attractive organ is an enlarged pinkish calyx-segment, the corolla being greenish and not visible a short distance away.

The principal modes of dissemination are by wind, resilient stems, and fleshy fruits, there being about a dozen cases of each kind.

The 78 species of vascular plants belong to about 63 genera and 42 families. The largest family in the list is Cyperaceæ, with 7 species.

Monocotyledons here constitute not quite 30% of the angiosperms, a much smaller proportion than in the moist pine-barrens, and about equalling that for the whole region. This is perhaps as good an indication as any that the branch-swamps are considerably nearer the mesophytic climax condition than are the moist pine-barrens.

In general range the species of this group resemble those of the preceding. Most of them are confined to the coastal plain.

6. Creeks and Small Rivers.

As the branches just described flow toward the sea they of course unite into creeks and those in turn into rivers. The distinction between a branch and a creek is one of degree rather than of kind, namely, a creek contains water all or nearly all the time, while a branch frequently dries up. The plants in the following list grow in streams of the third class described on a preceding page, *i. e.*, those which originate within the Altamaha Grit region and are rarely or never muddy. Streams of this class do not become very large before they leave the region, not large enough to be navigable, for instance. They do not usually have well-defined banks, and very often the whole channel is full of trees, as may be seen in the Allapaha and Little rivers within a few miles of Tifton. (See Plates VI, VII, and VIII, Fig. 1.) The water-level in these small endemic rivers varies a few feet at different seasons, but rarely gets beyond the edge of the swamp. The species here enumerated nearly all grow between high and low water marks.

6 Nyssa biflora
6 " Ogeche 4–5

4	Acer rubrum	2	red
4	Taxodium imbricarium	2–3	—
4	" (intermediate)	2–3	—
4	**Magnolia glauca**	4–7	white
3	**Pinus Tæda**	3–4	—
2	" **Elliottii**	2	—
2	" **serotina**	3–4	—
2	Liquidambar Styraciflua	3	—
1	Quercus nigra	3–4	—
1	Taxodium distichum	2–3	—
1	**Ilex opaca**	4–5	greenish
3	Fraxinus Caroliniana	3–4	
4	Cyrilla **racemiflora**	3–4	white
4	**Cliftonia monophylla**	6–7	white
4	***Bignonia crucigera***	3–5	red and yellow
3	Itea Virginica	4–6	white
3	Clethra alnifolia	7–8	white
2	**Pieris nitida**	3–4	white
2	**Viburnum nudum**		white
1	**Hypericum fasciculatum**	4–8	yellow
1	***Smilax laurifolia***		cream
1	**Serenoa serrulata**	6	cream
0	(**Phoradendron flavescens**)		
1	Aronia arbutifolia	3–4	white
1	**Leucothoë axillaris**	4–6	white
1	Leucothoe racemosa	4	white
1	Cholisma ligustrina	5–6	white
1	*Berchemia scandens*	5	greenish
6	Sabbatia foliosa ♃	6–8	purple
3	Lorinseria areolata ♃	0	0
3	Dulichium arundinaceum ♃	7–8	—
2	[**Dendropogon usneoides**]		
2	**Orontium aquaticum**	3	yellow
2	Xyris sp. (1700) ♃	8–9	yellow
2	Hymenocallis sp. ♃	4–5	white
1	Pluchea imbricata ♃	6–9	
1	Pontederia cordata ♃	4–8	blue
1	Iris versicolor ♃	4–5	blue
1	Ludwigia pilosa	6–9	
1	Rhynchospora glomerata paniculata	6–8	—
1	Lobelia flaccidifolia	6–7	blue
1	(*Cuscuta compacta*) ①	9	cream
1	Osmunda cinnamomea ♃	0	0
1	Asclepias lanceolata ♃	6–8	red

1 Uniola laxa ♃	7	—
1 Habenaria cristata ♃	7–8	yellow
1 Nymphæa fluviatilis ♃	6	yellow
1 Eriocaulon decangulare ♃	6–9	white
1 Fimbrystylis autumnalis ①	6–9	—
1 Rhynchospora corniculata ♃	6–8	—
1 Sparganium androcladum ♃	5–6	
1 Viola sp. (1675) ♃		white?
2 **Pallavicinia Lyellii**		
1 **[Porella pinnata]**		
2 **[Archilejeunea clypeata]**		
1 **[Schlotheimia Sullivantii]**		
1 **Scapania nemorosa**		
1 **Odontoschisma prostratum**		
1 **Sphagnum macrophyllum**		
1 **[Leskea denticulata]**		
1 **[Mastigolejeunea auriculata]**		
1 **Cephalozia Virginiana**		
1 Lycogala epidendrum		

Summary. Many of the remarks made about the flora of branch-swamps will apply almost as well to his group. This contains a few more species of trees and bryophytes, and fewer of shrubs and vascular herbs. Our commonest vascular epiphyte,

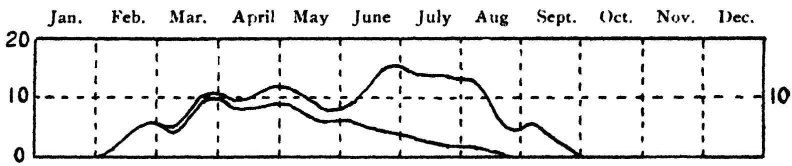

FIG. 7.

Phænological diagram for 46 plants of creek and small river-swamps, including 26 trees and shrubs.

Dendropogon usneoides, appears for the first time in this list.[1]

The 54 vascular plants enumerated belong to 47 genera and nearly as many families. The largest families are Coniferæ, Ericaceæ, and Cyperaceæ. The only composite in the list is more typical of other habitats, and the Scrophulariaceæ, Labiatæ,

[1]For references to anatomical studies of *Leucothoe racemosa*, *L. axillaris*, *Berchemia*, *Liquidambar*, *Itea*, *Magnolia glauca*, *Phoradendron*, *Dendropogon*, and *Dulichium* see the catalogue of species.

Euphorbiaceæ, and Leguminosæ are not represented at all.
As in the preceding list, most of the species are confined to the coastal plain.

7. Rivers and Creeks of the Second Class.

In the classification of streams on a preceding page those which rise in the upper third of the coastal plain are mentioned. To this class belong the Ohoopee (see Plate VIII, Fig. 2, and IX, Fig. 1) and Little Ohoopee rivers, which rise in Washington County, join with each other in Emanuel, and discharge into the Altamaha in Tattnall, also Gum Swamp Creek, which rises in Twiggs County, and unites with Alligator Creek to form the little Ocmulgee River just before it discharges into the Ocmulgee near Lumber City. These doubtless carry more calcium carbonate in solution than those previously mentioned, because they originate in more calcareous regions, and this is probably the principal reason for the difference in the flora of their swamps.

The following species are characteristic.

5 Taxodium (intermediate)	2–3	—
4 Nyssa uniflora	4	
4 **Pinus Tæda**	3–4	—
4 Planera aquatica	2–3	—
3 Nyssa Ogeche	4–5	
3 Acer rubrum	2	red
3 Fraxinus Caroliniana	3–4	
2 Nyssa biflora		
2 Betula nigra	3	—
1 Liquidambar Styraciflua	—	—
1 Taxodium distichum	2–3	—
1 Quercus lyrata	3	—
1 " Michauxii	—	—
1 " nigra	3–4	—
1 Salix nigra	4	cream
1 Gleditschia sp.		
1 **Pinus glabra**	3	—
1 **Juniperus Virginiana**	2–3	—
1 **Magnolia grandiflora**	5–6	cream
3 Viburnum obovatum	3–4	white
3 Cephalanthus occidentalis	6–9	white
3 Fraxinus Caroliniana	3–4	—
2 Cyrilla **racemiflora**	6–7	white

2 Cratægus apiifolia	—	white
2 *Berchemia scandens*	5	greenish
2 *Wistaria frutescens*	4	blue
2 Hypericum galioides pallidum	7	yellow
1 *Smilax Walteri*		
1 Sebastiana ligustrina	6	
1 **Sabal glabra**	6–7	white
1 Amorpha fruticosa		
1 Cratægus æstivalis		white
1 **Serenoa serrulata**	6	cream
1 *Trachelospermum difforme*	6	yellow
3 Nymphæa fluviatilis ♃	6	yellow
1 **Orontium aquaticum**	3	yellow
1 Carex bullata ♃	4	—
1 " folliculata ♃	4	—
1 Echinodorus radicans ♃		white
1 Carex triceps ♃	4	—
1 Lobelia flaccidifolia	6–7	blue
1 Carex debilis ♃	4	—
1 *Mikania scandens* ♃	7–10	white
1 Carex reniformis ♃	4	—
1 *Clematis crispa* ♃	4–9	pale blue
1 **[Brachelyma robustum]**		
1 **Fontinalis flaccida**		

Summary. In most particulars where this list differs from the preceding it approaches the next, so a detailed discussion will

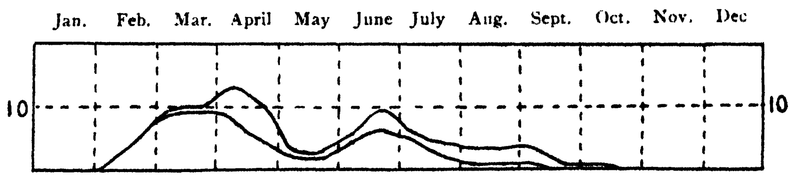

FIG. 8.

Phænological diagram for 37 plants growing in river and creek-swamps of the second class, including 27 trees and shrubs.

not be given here. But we may note in passing, the increasing number of trees and vines,[1] and the decreasing number of evergreens and herbs. There are no purple flowers.

It is interesting to note that the Gramineæ, the Ericaceæ, and

[1] For references to anatomical studies of *Berchemia* and *Liquidambar* see catalogue of species.

all plants with irregular gamopetalous corollas are absent, and that the Cyperaceæ are all of the genus *Carex*.

Nearly all of the species in this list grow in the upper third of the coastal plain, but not so many in the lower third. Nearly half of them extend up the Mississippi valley to Missouri or thereabouts, probably because of the abundance of swamps in that part of the country, and also because the older formations of the coastal plain are extensively developed there.

8. Muddy River-Swamps.

Next in order are the swamps of the rivers which rise in the Piedmont region and are always more or less muddy, namely, the Ogeechee, Oconee, and Ocmulgee. (See Plate IX, Fig. 2.) The Altamaha of course belongs to this class too, but no railroad crosses it in the territory assigned to this work, and I have not yet had a chance to examine it there. But the flora of its swamps down in the flat country is so similar to that along its two principal affluents, the Oconee and Ocmulgee, that there is no reason to believe that the unexplored portion presents any peculiarities in this respect. The muddy rivers are usually bordered with swamps on both sides, and it is rather the exception to find a bluff or steep bank rising abruptly from the water's edge to above the limits of inundation. But the swamps along these rivers in the Altamaha Grit region are not so extensive as in the upper third of the coastal plain, probably because the Grit is harder than most other coastal plain rocks and therefore stands higher above the streams.

The following plants characterize these swamps

7 Taxodium distichum	2-3	—
5 Liquidambar Styraciflua	3	—
4 Nyssa uniflora	4	
4 Salix nigra	4	cream
4 Planera aquatica	2-3	—
3 Fraxinus Caroliniana	3-4	
3 Quercus lyrata	3	—
2 Carpinus Caroliniana	3-4	—
2 Hicoria aquatica		—
2 Quercus Michauxii		—
1 Acer rubrum	2	red

2	Cratægus viridis	3–4	white
1	Betula nigra	3	—
2	**Pinus glabra**	3	—
1	" **Tæda**	3–4	—
1	Ulmus sp.		—
1	Quercus alba	4	—
1	" Phellos	4	—
4	*Ampelopsis arborea*	6	cream
4	**Sabal glabra**	6–7	white
4	Adelia acuminata		
4	Ilex decidua	3	white
3	Sebastiana ligustrina	6	
3	*Brunnichia cirrhosa* ♃	8	greenish
2	*Tecoma radicans*	5–10	red
2	*Rhus radicans*	5	cream
1	Cephalanthus occidentalis	6–9	white
2	*Trachelospermum difforme*	6	yellow
1	Cratægus apiifolia		white
1	Viburnum obovatum	3–4	white
1	Amorpha fruticosa		blue
1	Baccharis halimifolia		
1	Arundinaria sp.		
3	Saururus cernuus ♃	5	white
2	**[Dendropogon usneoides]**		
2	Nymphæa fluviatilis ♃	6	yellow
2	Baptisia leucantha ♃	4	
2	Echinodorus radicans ♃		white
1	**[Polypodium polypodioides]**	0	0
1	Asclepias perennis ♃	5–8	
1	Lobelia cardinalis ♃	7–9	red
1	Conoclinium cœlestinum ♃	7–11	blue
1	Anastrophus paspaloides	7–8	—
1	*Passiflora lutea* ♃	6–7	cream
1	Onoclea sensibilis ♃	0	0
1	Carex bullata ♃	4	—
1	Ludwigia glandulosa	7–8	greenish
1	Lycopus rubellus ♃	9	white
1	Carex glaucescens ♃	6–7	—
1	Triadenum petiolatum ♃	9	—
1	Carex debilis ♃	4	—
1	*Mikania scandens* ♃	7–10	white
1	Calophanes humistrata ♃	6	blue
1	Eupatorium serotinum ♃	8–9	white
1	Carex reniformis ♃	4	—
1	" intumescens ♃	4	—

1 Hymenocallis sp. ♃	7	white
1 Ludwigia alternifolia	6–9	yellow
1 Carex triceps? ♃	4	—
1 Scutellaria lateriflora ♃	9	blue
1 Carex squarrosa ♃	4	—
2 **[Porella pinnata]**		
1 **[Brachelyma robustum]**		

Summary. This habitat-group is noteworthy for containing seven vines and only five evergreens. This is a larger number of the former and a smaller number of the latter than in any previously mentioned group. The scarcity of evergreens makes these swamps look very lifeless in winter. The number of trees is the same as in the group immediately preceding. The herbs are mostly if not all perennials. Broad, thin leaves are the rule here, as in most swamps, principally because of the shade.[1]

The trees without exception flower between February and April, and most of them are wind-pollinated. The number of flowers of all kinds is greatest early in April, though there is a second but smaller maximum about the summer solstice. The average flowering period seems to be about 39 days.

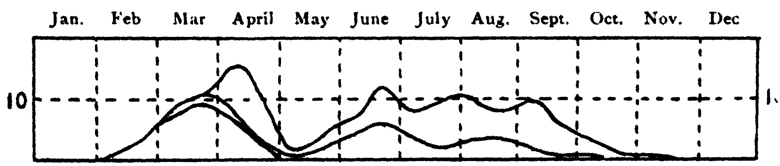

FIG. 9.

Phænological diagram for 49 plants of muddy river-swamps, including 15 trees and 10 shrubs.

The prevailing mode of dissemination seems to be through the agency of the wind, about 17 species having winged or comose seeds or fruits. Ten species have fleshy fruits. At least nine have fruits adapted to floating on the water, and it is very likely that the fruits of nearly all the species will float away if not taken care of otherwise. Five species of trees have nuts or acorns. The resilient herbaceous stems ("tonoboles"), so common in the

[1]For references to anatomical studies of *Baccharis*, *Liquidambar*, and *Dendropogon* see the catalogue.

moist pine-barrens, are rare here, and adhesive fruits are altogether wanting, which would seem to indicate that hairy quadrupeds do not frequent these swamps.

The number of species, genera, and families in this list is almost the same as for the creek-swamps. The largest family is Cyperaceæ, with seven species, all of the genus *Carex*. The Ericaceæ are conspicuous by their absence. Only 23.2% of the angiosperms are monocotyledons.

Probably every species in this list grows in the upper third of the coastal plain, and many of them extend still farther inland. Several of them are rare—and others absent—in Florida, doubtless because there is only one muddy river[1] in that state, the Apalachicola. It is noteworthy how many of these plants (something like half of them) extend up the Mississippi valley nearly or quite to the extreme edge of the coastal plain in southern Illinois. This points to an exceptional development of swamp vegetation along and near the Mississippi River.

These species are all strictly American, and mostly Eastern North American, probably none reaching the Pacific coast, and less than half a dozen reaching the West Indies.

Remarks on the Eight Preceding Lists.

The eight habitat-groups thus far discussed (with the possible exception of the rock outcrops) may be considered as forming a linear sequence. There is an almost perfect gradation from rocks through pine-barrens and branch-swamps to muddy river-swamps. This is proved by the fact that as a rule any species which occurs in more than one of these habitat-groups occurs only in consecutive groups. The same is perhaps true to a lesser extent of genera and families. For instance *Aster squarrosus* grows on rocks and in dry and intermediate pine-barrens; *Gaylussacia dumosa* in dry, intermediate, and moist pine-barrens; *Erigeron vernus* in intermediate and moist pine-barrens and branch-swamps; *Ludwigia pilosa* in moist pine-barrens, branch-swamps, and creek-swamps; and *Acer rubrum* in branch-swamps and all three classes of river-swamps. It is unusual however to

[1] *I. e.*, one which originates north of the pine-barrens and carries mineral sediment.

find any one species in more than two of these habitats, though some genera (*Pinus* for instance) are represented in all of them.

This particular sequence cannot be carried farther in the same direction, so we will now consider a series of habitats which are not so closely related to the preceding, namely, the ponds. These are principally of three kinds, cypress ponds, shallower ponds, and deeper ponds.

9. CYPRESS PONDS.

These ponds; (plate X, fig. 1.) characterized always by a rather dense growth of pond-cypress, *Taxodium imbricarium*, occur in most of the counties, but are rather scarce in the northernmost ones. They are simply shallow depressions in the otherwise nearly level pine-barrens, varying perhaps from one to a hundred acres in extent. (What originally caused these depressions I cannot say.) In wet weather they may contain two or three feet of water, but they dry up frequently enough to prevent floating aquatics like the Nymphæaceæ, *Potamogetons*, and some *Utricularias*, from establishing themselves. The cypress by reason of its erect branchlets and minute appressed leaves (quite different from those of its swamp-loving congener) gives little shade, and the cypress ponds are almost as sunny as the adjacent pine-barrens. The bottoms of these ponds are covered by a very thin layer of humus. The frequent desiccation and sunning to which they are subjected doubtless limits the accumulation of humus, as in the pine-barrens. The Columbia sand seems to be always present in these ponds, as in every other place where *Taxodium imbricarium* grows.

The following are the characteristic species of cypress ponds.

15	Taxodium imbricarium	2-3	—
11	**Pinus Elliottii**	2	—
2	Nyssa biflora		
1	**Ilex myrtifolia**		
6	**Ilex myrtifolia**		
6	**Hypericum myrtifolium**	6-9	yellow
3	" **fasciculatum**	4-8	yellow
2	**Pieris nitida**	3-4	white
1	Stillingia aquatica	4-7	yellow
1	Malapoenna geniculata		
1	***Pieris phillyreifolia***	2	white

9 Pontederia cordata ♃	4–8	blue
8 Polygala cymosa ②	5–9	yellow
7 Ludwigia pilosa ♃	6–9	
9 Coreopsis nudata ♃	4–6	purple
6 Rhynchospora axillaris ♃	5–7	—
8 Aristida palustris ♃	9	—
6 Eriocaulon compressum ♃	3–4	white
6 Sabbatia decandra ♃	7–8	purple
5 Scleria Baldwinii ♃	5–7	—
5 Pluchea bifrons ♃	6–9	
6 Dichromena latifolia ♃	5–7	white
4 Rudbeckia Mohrii ♃	6–9	yellow and dark purple
3 Lobelia Boykinii	5–6	blue
3 Centella repanda ♃	7–8	cream
3 Saururus cernuus ♃	5	white
3 Sclerolepis uniflora ♃	5–7	pinkish
2 Gratiola ramosa	6–7	
2 Pluchea imbricata ♃	6–9	
2 Xyris fimbriata ♃	7–9	yellow
2 **Juncus polycephalus** ♃	4–6	—
2 Rhynchospora corniculata ♃	6–8	—
2 Carex sp. ♃	4	—
1 " glaucescens ♃	6–7	—
1 Anchistea Virginica ♃	o	o
1 Rhynchospora filifolia ♃	6–7	—
1 Scleria gracilis ♃	5–7	—
1 Erigeron vernus ♃	4–8	white and yellow
1 Panicum stenodes ♃	6–9	—
1 Rhynchospora leptorhyncha ♃	6–7	—
1 Xyris Smalliana ♃	7–8	yellow
1 " sp. (1452) ♃	7–8	yellow
1 Ludwigia linifolia	7–9	yellow
1 Lycopus pubens ♃	9–10	white
1 Rhynchospora fascicularis ♃	7	—
1 Proserpinaca pectinata ♃	6–8	greenish
1 " palustris ♃	6–8	greenish
1 Hypericum acutifolium ♃	7–9	yellow
1 Rhexia stricta ♃	7–9	purple
1 Leptopoda Helenium ♃	4–5	yellow
1 Amsonia rigida ♃	5	blue
1 Eleocharis prolifera ♃		—
1 **Sphagnum macrophyllum**		

Summary. Perennial herbs are here much more numerous than woody plants, but one of the trees (the *Taxodium*) exceeds

in bulk all the rest of the vegetation combined. The trees and shrubs are mostly evergreen, but probably none of the herbs are. There are no vines (except the unique *Pieris phillyreifolia*), and no epiphytes or parasites have been noted.

Adaptations for reducing transpiration (principally taking the form of coriaceous or reduced leaves) are just as conspicuous here as in the pine-barrens. *Coreopsis nudata*, differing from all its congeners in having terete leaves, is an excellent example. *Saururus* and *Pontederia*, with broad thin cordate leaves, seem rather anomalous; but the *Saururus* is more frequently found in shaded places, and the *Pontederia* has narrower leaves in these ponds than anywhere else. Both of these species have a wide range, and are by no means confined to ponds.

An interesting character of the pond vegetation is that most of the species have their stems noticeably enlarged toward the base, more so than their congeners (if any) which grow in other habitats. This is most conspicuous in the cypress itself, but is pretty well exhibited by the *Pinus* and *Nyssa*. Among the herbs *Ludwigia pilosa* often has a spongy bark several times as thick as the rest of the stem, and many other species have stems which are perceptibly spongy inside toward the base.[1]

The number of flowers seems to be greatest in midsummer.

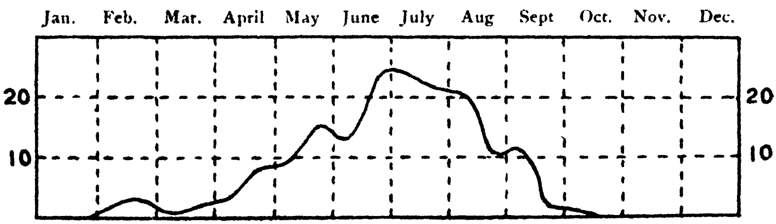

FIG. 10.

Phænological diagram for 46 plants of cypress ponds.

Fourteen species have anemophilous flowers, 11 yellow, 7 white, 3 purple, and 3 blue. The purple flowers (all pink purple) are much larger and more conspicuous than the blue, and also a little more abundant. The average flowering period is exceptionally long, 55 days.

[1] For references to morphological notes on *Pluchea bifrons*, *Stillingia aquatica*, and *Taxodium imbricarium* see the catalogue of species.

The modes of dissemination for these plants are not very well known. About half a dozen species have seeds transported by the wind, and two or three of the woody plants have drupes. There are a few instances of resilient stems ("tonoboles"), but these obviously would not scatter seeds from one pond to another. Probably as many seeds are carried on the feet of aquatic birds as in any other way.

Taxonomically the list contains 52 species belonging to about 38 genera and 26 families. Cyperaceæ is the largest family, as is often the case, and Compositæ next. There are only two species in the list between Euphorbiaceæ and Juncaceæ, and none between Polygalaceæ and Saururaceæ. *Rhynchospora* is the largest genus here, as in many other habitats. Nearly 40% of the angiosperms are monocotyledons.

These cypress-pond plants are quite restricted in range, doubtless because similar habitats are not very widespread. About half the species are confined to the pine-barren region, and only about 10% extend farther inland than the fall-line. Only about 35% range as far north as Virginia, in the coastal plain or otherwise. Seven species are reported from the tropics, but perhaps not correctly in every case. All but one or two have been reported from Florida, and they probably all grow in the flat pine-barrens of Southeast Georgia, where cypress ponds are common. A few are not known farther inland than the Altamaha Grit escarpment, but the majority range nearly throughout the pine-barrens of Georgia (as the typical species, *Taxodium imbricarium*, does). Almost none of them are reported up the Mississippi valley even as far as Arkansas. In this respect there is a marked contrast with the group just preceding this.

There is probably not a phytogeographical unit in the whole region more stable than the cypress ponds. While the glacial ponds in the north last only a very short time, geologically speaking, the cypress ponds probably have not changed materially in thousands of years, barring the works of man and possible climatic changes. Erosion is of course out of the question, and the quantity of humus (the principal factor which determines the life of a glacial pond) probably does not vary much, for the fires which get into the ponds occasionally in dry seasons doubt-

less keep the humus down, if nothing else does. The number of species adapted to growing in such places is limited, and those which are easily disseminated are already established nearly everywhere. The individual cypress trees themselves show a certain amount of stability, for their ages are often reckoned in hundreds of years.

10. Shallower Pine-Barren Ponds.

Toward the inland edge of the Altamaha Grit region, particularly in Bulloch, Dooly, Irwin, Berrien, and Colquitt counties, are found shallow pine-barren ponds, which while not essentially distinct from the cypress ponds, usually contain no cypress, and are probably empty of water half the time. The Columbia sand seems to be thinner in these ponds than in the cypress ponds, and is probably sometimes entirely absent. Their flora consists principally of the following species.

2 **Pinus Elliottii**	2	—
2 Nyssa biflora		
1 Taxodium imbricarium	2–3	—
6 **Hypericum myrtifolium**	6–9	yellow
2 **Ilex myrtifolia**		
1 Cephalanthus occidentalis	6–9	white
2 Diospyros Virginiana	5	white
2 **Serenoa serrulata**	6	cream
1 (**Phoradendron flavescens**)		
1 Malapoenna geniculata		
4 Gratiola ramosa	6–7	
3 Dichromena latifolia ♃	5–7	white
3 Rudbeckia Mohrii ♃	6–9	yellow and dark purple
3 Pluchea bifrons ♃	6–9	
3 Aristida palustris ♃	9	—
3 Scleria gracilis ♃	5–7	—
2 Ludwigia pilosa ♃	6–9	
2 Coreopsis nudata ♃	4–6	purple
2 Isnardia palustris ♃	5–9	greenish
2 Leptopoda Helenium ♃	4–5	yellow
2 *Breweria aquatica* ♃	6–7	purple
2 Rhynchospora axillaris ♃	5–7	—
2 Ludwigia linifolia	7–9	yellow
2 Tridens ambiguus ♃	6–9	—
2 Manisuris Chapmani ♃	8–9	—
2 Chondrophora nudata ♃	8–9	yellow

1 Hypericum gymnanthum ①		yellow
1 Kœllia hyssopifolia ♃		
1 **Juncus repens**	6	—
1 Proserpinaca pectinata ♃	5–8	greenish
1 Panicum stenodes ♃	6–9	—
1 Sclerolepis uniflora ♃	5–7	pinkish
1 Eriocaulon compressum ♃	3–4	white
1 Diodia sp. (1682)	9	white
1 Sabbatia campanulata	6–8	purple
1 Eriocaulon decangulare ♃	6–9	white
1 Monniera Caroliniana ♃	7–8	blue
1 Rhexia Alifanus ♃	6–8	purple
1 Sporobolus Floridanus ♃	9	—
1 Gerardia linifolia ♃	8–9	purple
1 Mesosphærum radiatum ♃	6–8	
1 Fuirena breviseta ♃	7–9	—
1 Amsonia rigida ♃	5	blue
1 Eleocharis prolifera ♃		—
1 Rhynchospora perplexa		—
1 Carex glaucescens ♃	6–7	—
1 Panicum Combsii ♃	9	—
1 Eupatorium Mohrii ♃	9	white
1 Lachnocaulon anceps ♃	4–8	white
1 Polygala ramosa ②	5–9	yellow
1 Lycopus pubens ♃	9–10	white
1 Polygala Chapmani ①	7	purple
1 Xyris sp. (1574) ♃	8–9	yellow
1 Rhexia lutea ♃	6–7	yellow
1 Euthamia Caroliniana ♃	9–10	yellow
1 Panicum melicarium	5–7	—
1 Tofieldia racemosa ♃	6–8	white
1 Sarracenia minor ♃	4–5	yellow
1 Laciniaria spicata ♃	8–10	purple
1 Juncus biflorus ♃	5–6	—

Summary. This group does not differ greatly from the preceding. The only vine is *Breweria aquatica*, a perennial herb. The proportion of trees, shrubs, and herbs is about the same as in the cypress ponds.[1]

About the same families are represented, but the shallower ponds contain more Compositæ and Gramineæ than the cypress ponds, and fewer Cyperaceæ. There are no Ericaceæ or Legu-

[1] For references to anatomical studies of *Pluchea bifrons*, *Juncus repens*, and *Eriocaulon decangulare* see the catalogue.

minosæ. Compositæ is the largest family, with Cyperaceæ and Gramineæ a tie for second place. Cryptogams are rare or absent, and monocotyledons constitute about 37% of the whole list.

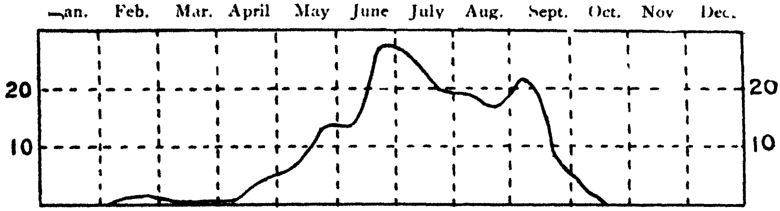

FIG. 11.

Phænological diagram for 52 plants of shallow pine-barren ponds.

The ranges of these species are slightly different from those of the cypress ponds. Nearly all of them occur in the Lower Oligocene region, but not quite so many are known in the flat pine-barren country. Nearly all have also been reported from Florida, but quite a number only from the northwestern part of that state.

11. PONDS ALONG THE ALTAMAHA GRIT ESCARPMENT.

Just at the inland edge of our territory, perhaps occupying holes in the thin edge of the Altamaha Grit, are a number of small but apparently permanent pine-barren ponds. These are too few and scattered to contain a very rich flora. The following species have been observed in such places in Screven, Wilcox, and Decatur Counties.

(For explanation of asterisks see summary.)

3 Taxodium imbricarium	2–3	—
2 **Pinus Elliottii**	2	—
1 Nyssa biflora		
2 **Hypericum fasciculatum**	4–8	yellow
2 Cephalanthus occidentalis	6–9	white
1 Nyssa Ogeche	4–5	—
1 **Pieris nitida**	3–4	white
1 **Magnolia glauca**	4–7	white
*3 Myriophyllum heterophyllum ♃		
*2 Brasenia purpurea ♃	5–6	purple
2 Pontederia cordata ♃	4–8	blue
2 Iris versicolor ♃	4–5	blue
*2 Utricularia inflata ♃	3–7	yellow

2 Carex sp. ♃	4	—
1 Eriocaulon compressum ♃	3–4	white
*1 Castalia odorata ♃	4–8	white
1 Xyris fimbriata ♃	7–9	yellow
*1 Scirpus cylindricus ♃	5–6	—
1 Anchistea Virginica ♃	o	o
1 Gratiola ramosa	6–7	—
1 Sclerolepis uniflora ♃	5–7	pinkish
1 Carex alata ♃	4	—
*1 Eleocharis interstincta ♃	5–6	—
*1 Ludwigia sphærocarpa ♃		
1 Dulichium arundinaceum ♃	7–8	—
*1 Limnanthemum aquaticum ♃	6–9	white
1 Carex venusta ♃	4	—
1 **Sphagnum macrophyllum**		

Summary. There is little noteworthy about these plants except their ranges. All of them except *Nyssa Ogeche* grow in many places in the adjacent Lower Oligocene region, but nearly a third of the species (the names of which are starred) are not known to be native elsewhere in the Altamaha Grit region (doubtless because they require permanent water), though some of these grow also in artificial ponds and ditches. At least a dozen range northward to the glaciated region, where they usually occupy similar habitats.[1] Five or six are reported also from the tropics, but their identity or indigeneity there may in some cases be questioned.

12. Sand-Hills.

Most of the habitats hitherto discussed may be considered as located on the right-hand side of some creek or river. If we cross the stream we find quite a different series of habitats, of which the sand-hills are the type. (Plate X, fig. 2, and Plate XI.) Sand-hills have been described on an earlier page (21). Their most prominent characteristic is the sparsity of vegetation, and consequent lack of shade and humus, together with conspicuous adaptations for reducing transpiration in most of the plants.[2]

[1] See *Rhodora*, 7: 76. April, 1905.

[2] For references to anatomical or morphological notes on *Chrysoma pauciflosculosa*, *Galium hispidulum*, *Asclepias humistrata*, *A. verticillata*, *Batodendron arboreum*, *Lupinus perennis*, *Baptisia perfoliata*, *Dendropogon usneoides*, *Cyperus retrofractus*, and *Pinus palustris* see the catalogue of species.

In these respects they resemble deserts, but the dryness of the sand-hills is of course in the soil, and not in the air as in most desert regions. The Columbia or Ozark sand of which the sand-hills are composed is always too deep for any roots to reach the bottom of it, and it is practically homogeneous from top to bottom, except the very uppermost layer which is exposed to the atmosphere and is usually whiter than the rest. Analyses of this kind of soil in Dodge and Decatur counties and other parts of the southeastern coastal plain by the U. S. Bureau of Soils show usually about 10% of clay and silt, less than 1% of organic matter, and the rest all sand. The whiteness of the sand together with the sparsity of the vegetation makes the sand-hills conspicuous. They probably constitute about 10% of the area northeast of the Altamaha River and 5% of the remainder of the region. They have been little damaged by civilization, except that many if not most of the pines on them have been turpentined or removed. Fires sweep over the sand-hills occasionally, but there is so little grass to burn that not much damage is done, except to trees which have been turpentined. The land is of little value agriculturally, and has few buildings on it other than churches.

The following list of plants has been compiled from about 25 different sand-hill areas widely distributed over the region.

25	Quercus Catesbæi	3	—
14	Quercus brevifolia	3	—
11	**Pinus palustris**	3	—
10	Quercus Margaretta	3–4	—
9	Quercus geminata	4	—
1	Cratægus Michauxii?		white
1	Diospyros Virginiana	4–5	white
17	Chrysobalanus **oblongifolius**	6	white
14	**Serenoa serrulata**	6	cream
13	Polycodium cæsium	4	white
7	**Ceanothus microphyllus**	4–5	white
4	**Batodendron arboreum**	5	white
4	**Gaylussacia dumosa**	4	white
5	Clinopodium coccineum		red
6	Polygonella Croomii	9	white
3	Asimina angustifolia	5	cream
2	**Cholisma ferruginea**	5	white

2	Asimina speciosa	4–5	cream
2	Rhus Toxicodendron		cream
2	Bumelia reclinata		
2	**Chrysoma pauciflosculosa**	9	yellow
1	Cratægus uniflora		white
1	Bumelia lanuginosa		cream
1	**Myrica pumila**		—
1	Ceanothus Americanus	5–6	white
1	Pieris Mariana	4–5	white
1	Elliottia racemosa	6–7	white
24	Eriogonum tomentosum ♃	7–9	cream
21	Kuhnistera pinnata ♃	9–10	white
16	Cracca Virginiana ♃	4–5	cream and purple
17	Actinospermum angustifolium ①	9	yellow
15	Stipulicida setacea ♃	4–7	white
15	Rhynchospora Grayii ♃	4–6	—
6	Baptisia perfoliata ♃	4–6	yellow
12	Psoralea Lupinellus ♃	6–7	blue
9	**Arenaria Caroliniana**	4–6	white
9	Cuthbertia graminea ♃	5–7	pinkish
11	Dasystoma pectinata ①	8–9	yellow
9	Stillingia sylvatica ♃	4–7	yellow
8	Stenophyllus cilliatifolius ①	7–9	—
8	Euphorbia gracilis ♃	4–8	dark purple
8	Stylosanthes biflora ♃	5–7	yellow
9	Stenophyllus Warei ①	7–8	—
8	Aristida stricta ♃	9	—
8	Paronychia herniarioides ① or ②	6–7	greenish
8	Croton argyranthemus ♃	5–8	
8	Laciniaria tenuifolia ♃	8–10	purple
7	Dolicholus simplicifolius ♃	4–9	yellow
8	Indigofera Carolainina ♃	6–8	•
8	Lupinus diffusus ♃	4	blue
7	*Krameria secundiflora* ♃	6–7	dark purple
7	Chrysopsis graminifolia ♃	8–11	yellow
7	Afzelia pectinata ①	8–9	yellow
6	*Breweria humistrata* ♃	5–9	white
6	Solidago odora ♃	9–10	yellow
6	Asclepias humistrata ♃	4–6	gray-purple
6	Sericocarpus bifoliatus ♃	8–9	white
6	Gerardia filifolia ①	9	purple
6	Lupinus perennis ♃	4	blue
6	**Opuntia vulgaris** ♃	5–7	yellow
5	Amsonia tenuifolia ♃	4–5	pale blue
5	Dicerandra odoratissima ①	9–10	white

6 Tium apilosum ♃	6	cream
4 Polygonella gracilis ①	9	white
6 Thysanella fimbriata ①	9–10	white
5 Scleria glabra ♃		—
5 Pteridium ♃	0	0
5 *Galactia regularis* ♃	6–7	purple
4 Jatropha stimulosa ♃	4–9	white
6 Triplasis Americana ♃	9–10	—
4 Sporobolus gracilis ♃	7–9	—
4 Euphorbia corollata ♃	4–11	white
4 Laciniaria elegans ♃	8–10	white
4 Chrysopsis gossypina ♃	9–10	yellow
4 Psoralea canescens ♃	5–6	blue
4 Vernonia angustifolia ♃	7–8	purple
4 Berlandiera pumila ♃	4–9	yellow
3 Lechea tenuifolia ♃		
3 Siphonychia pauciflora ① or ②	6–9	white
3 **Phlox subulata**	3–6	pale blue
3 Meibomia tenuifolia	9–10	purple
2 **Smilax pumila**	9	cream
3 Gaura Michauxii ②	7–10	pinkish
3 Sorghastrum secundum ♃	9–10	—
3 Crotalaria rotundifolia ♃	5–10	yellow
4 Warea cuneifolia ①	7–9	pale blue
3 Galium hispidulum ♃		cream
3 Trichostema lineare ①	8–10	blue
3 **Selaginella acanthonota**	0	0
3 *Siphonychia Americana* ♃	9–10	white
3 Salvia azurea ♃	9–10	blue or white
2 Cyperus retrofractus ♃	7–8	—
2 Verbena carnea ♃	4–7	pinkish
2 Aristida condensata ♃	9	—
2 Calophanes oblongifolia ♃	4–6	blue
2 *Morongia uncinata* ♃	5–6	purple
2 *Zornia bracteata* ♃	6–9	yellow
2 Eupatorium album ♃	7–9	white
2 Lespedeza hirta ♃	9	cream
2 Froelichia Floridana ①	7–8	white
2 **Houstonia rotundifolia**	2–4	white
2 Clitoria Mariana ♃	5–8	blue
2 **Yucca filamentosa**	5–6	cream
2 [**Dendropogon usneoides**]		
2 Petalostemon albidus ♃	8–9	white
2 Dicerandra linearifolia ①	9–10	white
2 Angelica dentata ♃	9–10	white

2 Baptisia lanceolata ♃	3–4	yellow
1 Asclepias verticillata ♃	6–9	white
1 Tradescantia reflexa ♃	6–7	blue
1 *Lespedeza repens* ♃	9	purple
1 *Meibomia arenicola*	9–10	purple
1 Anthænantia villosa ♃	8–10	—
2 Carex tenax ♃	4	—
1 Ruellia humilis ♃	6	blue
1 Euphorbia Floridana ♃	7–8	
1 Sarothra gentianoides ①	6–10	yellow
1 **Nolina Georgiana**	5	
1 Cyperus Martindalei ♃	6–7	—
1 Asclepias tuberosa ♃	5–9	orange
1 Gaillardia lanceolata ① or ②	6–9	yellow and dark purple
1 Pentstemon multiflorus ♃	8–10	white
1 Coreopsis delphinifolia ♃	6–8	yellow
1 Aldenella tenuifolia ①	6–8	white
1 Aristida sp. (1988) ♃	9	—
1 Solidago Boottii ♃	9	yellow
1 Coreopsis lanceolata ♃	4–6	yellow
1 Polygonella sp. (2010) ①	9	white
1 Pentstemon hirsutus ♃	4–6	purple
1 Helianthus Radula ♃	9–10	dark purple
1 Batschia Carolinensis ♃	5–6	orange
1 Onosmodium Virginianum ♃	5–6	cream
1 Euphorbia cordifolia ①	9	greenish
2 Astræus hygrometricus		
1 **Dicranum Bonjeani**		

Summary. The sand-hill vegetation is more like that of the dry pine-barrens than any other previously discussed. A little more than half of the species in each of these habitats are common to both, but their order of abundance is very different in the two lists, and if only the 25 most abundant species in each were considered there would be very few in common. The proportion of trees, shrubs, and herbs is almost identical in the two groups.

Quercus Catesbæi probably exceeds in numbers all other trees on the sand-hills combined. It would be hard to find a Georgia sand-hill without this tree and *Eriogonum tomentosum*, the most abundant herb. An interesting feature of the sand-hill flora is the occurrence of three rare shrubs, *Chrysoma*, *Clinopodium*, and *Polygonella Croomii*, belonging to families which are mostly herbaceous.

About one-eighth of the species in the above list are evergreen, but most of the evergreens are not abundant, so the sand-hills have quite a desolate appearance in winter. There are half a dozen or more perennial herbaceous vines, but these usually do not climb. Instead they trail over the bare sand, where there is plenty of room. Perennial herbs are in the majority here as in most of the groups already discussed, but there are more annuals on the sand-hills than in any other habitat.

Almost every sand-hill plant has some evident contrivance for reducing transpiration. *Quercus Catesbæi*, the commonest species, is a good example. Its leaves are coriaceous, apparently about alike on both sides, and turned at all sorts of angles to the horizon, so that only a few of them receive the full effect of the sun's rays at any one time. Glaucous and woolly leaves are quite common. *Asclepias humistrata* (see plate XIX, fig. 1), *Baptisia perfoliata*, *Polygonella gracilis*, *Chrysopsis gossypina*, *Sericocarpus bifoliatus*, *Chrysoma pauciflosculosa*, and probably other species, have their leaves vertical, and alike or nearly so on both surfaces.[1] In *Stipulicida setacea*, one of the slenderest plants imaginable, and many other species, the same end is accomplished by reduction of leaf-surface.[2]

There are few spring flowers on the sand-hills, which is not surprising, since it is well known that vernal-flowering plants are usually most numerous in dense deciduous forests, where the ground is covered with humus, and the sand-hills are just the opposite of this. The species which bloom before April are mostly trees. The annual plants mostly bloom between July 1st and October 1st. The height of the flowering season for the whole sand-hill flora seems to be in September. (See diagram.) The average length of the flowering period is 51 days.

The proportions of the various colors of flowers are almost the same as in dry pine-barrens. Only 20 species are anemophilous, and of the entomophilous ones about 36 have white flowers, 12 cream-colored, 21 yellow, 9 purple, and 12 blue. Apparently the sand-hill insects are not as fond of purple as are those which

1 See *Bull. Torrey Club*, **30**: 336, 339. 1903.

2 The frequent occurrence in this group of such specific names as *angustifolia*, *filifolia*, *gracilis*, *lanceolata*, *pectinata* and *tenuifolia* is suggestive.

live on the other side of the creek, where purple flowers are much more numerous.

As usual, the modes of dissemination are not known for more than half the species. About 17 species have wind-borne seeds, and 15 fleshy fruits. Some of the latter are berries which can only

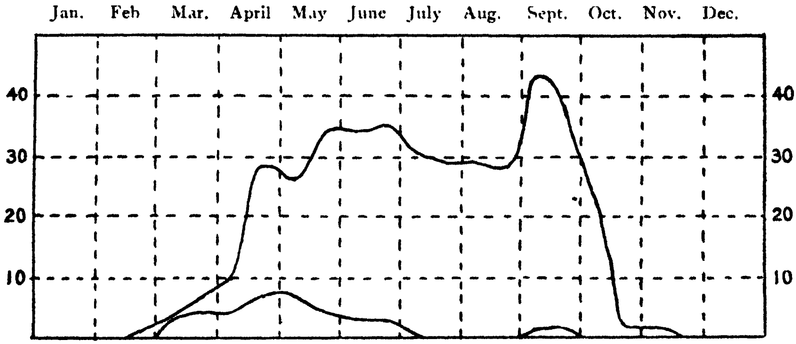

FIG. 12.

Phænological diagram for 120 sand-hill plants, including 20 trees and shrubs.

be reached by birds, while others are larger fruits close to the ground for the benefit of terrestrial animals. Nine or ten species are "tonoboles" (see p. 61) and about the same number have adhesive fruits. A few of the Leguminosæ have pods which open suddenly with a twisting motion, and expel the seeds in that way. One of these, *Clitoria Mariana*, has sticky seeds which are probably adapted to adhere to any animal which may be passing at the time they are discharged. There are at least four tumble-weeds in the list.

The list contains 133 species belonging to about 103 genera and 45 families (a larger number of genera and families than in the dry pine-barrens, but a smaller number of species). The largest family is Leguminosæ, with 22 species, and the next Compositæ, with 16. Euphorbiaceæ, Cyperaceæ, and Gramineæ tie for third place, with seven each. The Gentianaceæ and Polygalaceae are conspicuous by their absence. The largest genera are *Euphorbia* and *Quercus*, with four species each. Cryptogams are represented by two pteridophytes, one moss,

and one fungus. Only 17.6% of the angiosperms (about the same proportion as in dry pine-barrens) are monocotyledons, which seems to indicate that the sand-hill flora is pretty highly specialized.

The following families have at least two more representatives on the sand-hills than in the dry pine-barrens: Caryophyllaceæ, Illecebraceæ, Polygonaceæ, and Commelinaceæ. The reverse is true of Compositæ, Polygalaceæ, Cupuliferæ, and Gramineæ.

In range the sand-hill plants are more restricted than those of dry pine-barrens. Those peculiar to the sand-hills are nearly all confined to the coastal plain, and conversely, those whose ranges cross the fall-line nearly all occur also in dry pine-barrens. Most of the characteristic sand-hill plants do not range farther north than North Carolina or farther west than Mississippi. (This throws an interesting side-light on the geographical distribution of coastal-plain sand-hills.) About two-thirds of the whole list occur also on the fall-line sand-hills of Georgia (according to notes from Richmond County furnished by Mr. A. Cuthbert, and my own observations there and elsewhere along the fall-line).

A few of the species listed are not yet known outside of Georgia, and at least one of these (*Dicerandra odoratissima*) is perhaps really confined to the state. Only one species in the list is known from the tropics, and that (*Dendropogon usneoides*) is an epiphyte, by no means confined to sand-hills.

In descending from the summit of a sand-hill toward the creek at its base, we may pass through either of two series of intermediate habitats, bogs or hammocks. Approaching a springy place in the sand-hills, or a branch passing through them, we usually encounter first a slightly damp area, analogous to the intermediate (rather dry) pine-barrens on the other side of the creek. For want of a better designation this may be called

13. Intermediate Sand-Hills.

The flora of such habitats is rather meager, and not sharply distinguished from those on either side of it. The following species are characteristic.

2 **Pinus serotina**	3–4	—
5 **Kalmia hirsuta**	6–9	purple

3 **Cholisma ferruginea**	5	white
2 **Vaccinium nitidum**		
1 **Ilex glabra**	4–5	white
1 **Myrica Carolinensis**		—
1 **Cliftonia monophylla**	3–4	white
1 **Serenoa serrulata**	6	cream
1 Gaylussacia frondosa	4	
1 Leucothoe elongata		white
1 Pieris Mariana	4–5	white
1 **Hypericum myrtifolium**	6–9	yellow
3 Juncus biflorus ♃	5–6	—
3 Pterocaulon undulatum ♃	5–6	cream
3 Polygala lutea ②	4–9	orange
2 Lachnocaulon anceps ♃	4–8	white
2 Trilisa odoratissima ♃	8–9	purple
2 Syngonanthus flavidulus ♃	5–9	cream
1 Lechea Torreyi ♃		
1 Juncus scirpoides compositus ♃	7	—
1 Aristida spiciformis ♃	7–9	—
1 Xyris fimbriata ♃	7–9	yellow
1 Pteridium ♃	o	o
1 Xyris brevifolia ②	4	yellow
1 Sophronanthe hispida ♃	7–9	white
1 Sabbatia Elliottii	9–10	white
1 Doellingeria reticulata ♃		white and yellow
1 Xyris Elliottii ♃	6–8	yellow
1 Rhynchospora ciliaris ♃	5–8	—
1 Rhexia filiformis	6–9	white
1 Polygala nana ②	4–6	yellow
1 Zygadenus glaberrimus ♃	7–8	white

As the species in this list are so few, and nearly all grow also in the intermediate pine-barrens or in some of the habitats to be mentioned below, it is not worth while to summarize much concerning them. It will be noticed that most of the woody plants are evergreen.

14. Sand-Hill Bogs.

The branches in the sand-hills are analogous to those in the pine-barrens, and have a somewhat similar flora. The differences between the two are doubtless due mostly to the much greater thickness of the Columbia formation on the sand-hills. In boggy places at the heads of the sand-hill branches (plate XII, fig. 2) are found the following species.

6 **Pinus serotina**	3–4	—
4 **Magnolia glauca**	4–7	white
1 Persea pubescens		
2 **Gordonia Lasianthus**	7–9	white
2 **Pinus Tæda**	3–4	—
1 Liriodendron Tulipifera	4	cream
6 **Cliftonia monophylla**	3–4	white
4 Rhus Vernix		cream
3 **Myrica Carolinensis**		—
3 **Pieris nitida**	3–4	white
3 Clethra alnifolia	7–8	white
2 Pinckneya pubens	6–7	pink
3 Gaylussacia frondosa	4	
2 **Ilex glabra**	4–5	white
2 **Ilex coriacea**	5–6	white
2 ***Smilax laurifolia***		cream
1 **Viburnum nudum**		white
1 Aronia arbutifolia	3–4	white
1 **Leucothoë axillaris**	4–6	white
1 **Hypericum opacum**	7–9	yellow
2 Osmunda cinnamomea ♃	o	o
2 **Lycopodium alopecuroides**	o	o
2 Pogonia ophioglossoides ♃	4–5	purple
2 Tracyanthus angustifolius ♃	4–5	cream
2 Anchistea Virginica ♃	o	o
2 Polygala lutea ②	4–9	orange
2 Sarracenia rubra ♃	4	red
2 Utricularia subulata	4–7	yellow
1 **Mayaca Aubleti**	6–9	pinkish
1 Habenaria blephariglottis ♃	8–9	white
1 Centella repanda ♃	7–8	cream
1 Pteridium ♃	o	o
1 Xyris fimbriata ♃	7–9	yellow
1 Habenaria ciliaris ♃	7–8	orange
1 Rhexia ciliosa ♃	6–9	purple
1 Habenaria cristata ♃	7–8	yellow
1 Juncus trigonocarpus ♃	8–9	—
2 Oceanoros leimanthoides ♃	6	white
1 Xyris platylepis ♃	7–8	yellow
1 **Sarracenia purpurea**	3–4	red
1 Carex Elliottii ♃	4	—
1 Erianthus brevibarbis ♃	9	—
1 Panicum verrucosum ♃	9	—
1 Sarracenia flava ♃	4	yellow
1 " minor ♃	4–5	yellow

1	Zygadenus glaberrimus ♃	7–8	white
1	Habenaria blephariglottis × ciliaris ♃	8	cream
1	Cyperus Haspan ♃	6–8	—
1	Marshallia graminifolia ♃	7–9	pale purple
1	Mesosphærum radiatum ♃	6–8	
1	Macranthera fuchsioides ♃	9–10	orange
1	Ludwigia pilosa ♃	6–9	
1	*Apios tuberosa* ♃	8	dark purple
1	(*Cuscuta compacta*) ①	9	cream

1 **Sphagnum tenerum** (and doubtless other species)
1 **Batrachospermum vagum keratophytum**

Summary. The flora of the sand-hill bogs can best be compared with that of moist pine-barrens and branch-swamps, already discussed. The woody plants are much more abundant and conspicuous than the herbs (usually growing so densely that these bogs are difficult to penetrate), and about two-thirds of them are evergreen. There are three vines, one quite common, a woody evergreen, and the other two rarer, one a perennial herb and the other an annual parasite. Nearly all the herbs are perennial.[1]

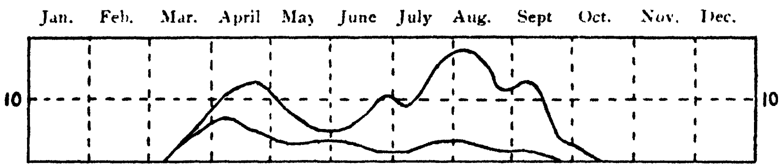

FIG. 13.

Phænological diagram for 45 plants of sand-hill bogs, including 15 trees and shrubs.

I know of no flowers in these bogs earlier than March or later than October. Perhaps the flowering season is thus restricted by the cold, shaded, water-soaked soil, with its covering of peat. The height of the flowering season seems to be in August, but there is another conspicuous maximum in April. The average flowering period is about 43 days.

The proportions of various colors of flowers are about the same

[1] For references to anatomical studies of *Leucothæ axillaris*, *Ilex glabra*, *Magnolia glauca*, *Myrica Carolinensis*, and *Smilax laurifolia* see the catalogue.

as on the adjacent sand-hills. (Perhaps this indicates that they are pollinated by the same insects.) There are 8 anemophilous species, 13 with white flowers, 7 cream, 7 yellow, 2 purple, 2 red, and 3 orange.

The list shows 56 species in about 47 genera and 35 families. 35.4% of the angiosperms are monocotyledons. Orchidaceæ is the largest family and *Sarraccnia* and *Habenaria* the largest genera. Grasses and sedges are scarce.

The generalized ranges of these plants do not differ much from those in the moist pine-barrens and branch-swamps, except that a somewhat larger proportion of them grow in similar habitats in the glaciated region of the north.[1]

15. Non-Alluvial Creek-Swamps.

Entering the swamp of a creek or small river from the sand-hill (left) side, we usually find that part of it above the reach of inundation to be kept perpetually moist by springs issuing from the sand-hills. Being usually densely shaded by large trees the temperature of such a place is of course considerably lower than that of the sand-hills on one side and the alluvial swamp (with its warmer water) on the other. A splendid example of such a swamp can be seen at Gaskin's Spring on Seventeen Mile Creek in Coffee County. (See Plates XIII and XIV, Fig. 1.) This has been visited in February, May, July, and September, and in four different years, and most of the following species have been oberved there.

5 **Magnolia glauca**	4–7	white
4 **Gordonia Lasianthus**	7–9	white
4 **Persea pubescens**		
3 **Pinus Tæda**	3–4	—
2 **Cliftonia monophylla**	3–4	white
1 **Osmanthus Americana**		
0 **Pinus serotina**	3–4	—
3 Itea Virginica	4–6	white
2 **Leucothoë axillaris**	4–6	white
2 *Vitis rotundifolia*	5	cream
2 Viburnum nitidum	4	white
1 **Ilex coriacea**	5–6	white
1 **Viburnum nudum**		white
1 ***Smilax laurifolia***		cream

[1] See *Rhodora*, **7**: 69–80, April, 1905

1 **Pieris nitida**	3–4	white
1 Alnus rugosa	1–2	—
1 Lorinseria areolata ♃	0	0
0 Dulichium arundinaceum ♃	7–8	—
1 Carex Elliottii ♃	4	—
3 Peltandra sagittæfolia ♃	5–7	white
1 Xyris sp. (1700) ♃	8–9	yellow
1 **[Epidendrum conopseum]**	6–7	cream
2 **Sphagnum cuspidatum**		
1 " **cymbifolium**		
1 **Rhizogonium spiniforme**		
1 **Bazzania trilobata**		
2 **Odontoschisma prostratum**		
1 **Thuidium sp.** (1700 a)		
1 **Pallavicinia Lyellii**		
2 **[Plagiochila undata]**		
2 **[" Ludoviciana]**		
2 **Isopterygium micans**		
1 **Radula sp**		
1 **Frullania Caroliniana**		
1 " **Kunzei**		
1 **Lejeunea Americana**		
1 **Harpalajeunea ovata**		
1 (POLYPORUS VERSICOLOR)		
1 (SCHIZOPHYLLUM COMMUNE)		

Summary. This group is somewhat intermediate between the sand-hill bogs and the ordinary alluvial creek-swamps already discussed, but differs from both, and probably from all other habitat-groups in the region, in the larger proportion of evergreens, and of bryophytes. There is the greatest possible contrast between these swamps and the sand-hills near by, in almost every respect. Particularly is this true in winter, when nearly all vegetation on the sand-hills looks dead, while that in the non-alluvial swamps looks about the same as in summer.[1] There are no species common to the two places, and not many families even.

In these swamps all the trees and most of the shrubs are evergreen. The few and relatively inconspicuous herbs are all perennial, and all either monocotyledons or cryptogams. Flowers

[1] For references to anatomical studies of *Leucothoë axillaris*, *Persea pubescens*, *Ilex coriacea*, *Itea Virginica*, *Magnolia glauca*, *Smilax laurifolia*, and *Dulichium* see the catalogue of species.

are rather scarce and inconspicuous. In May as many as half a dozen species may be in bloom at once, but there are not so many at other times, and apparently none after September. White is the prevailing color. Nearly half the flowering plants have fleshy fruits.

Of vascular plants there are only 22 species, belonging to nearly as many families and genera. In range they are chiefly confined to the coastal plain (but not to the pine-barren region). Most of them do not range farther north than Virginia or farther west than Louisiana.

16. Sand-Hill Ponds.

Ponds occur in the sand-hills as well as in the pine-barrens, but much more rarely. There seem to be no references to sand-hill ponds in botanical literature, and perhaps they do not occur outside of Georgia. They seem to be a little more common in Coffee County than anywhere else. They are usually quite small, and contain no water except in wet weather (Plate XIV, Fig. 2). The following species grow in them or around their edges.

2 **Pinus Elliottii**	2	—
1 Nyssa biflora		
2 **Ilex glabra**	4–5	white
2 Leucothoe elongata		white
1 **Hypericum myrtifolium**	6–9	yellow
1 **Kalmia hirsuta**	6–9	purple
1 **Cliftonia monophylla**	3–4	white
1 **Pieris nitida**	3–4	white
1 **Cyrilla racemiflora**	6–7	white
1 **Hypericum fasciculatum**	4–8	yellow
1 **Serenoa serrulata**	6	cream
1 **Persea pubescens**		
1 Pieris Mariana	4–5	white
1 Malapoenna geniculata		
1 Benzoin melissæfolium		
3 Juncus scirpoides compositus ♃	7	—
3 Syngonanthus flavidulus ♃	5–9	cream
2 Aristida spiciformis	7–9	—
2 Xyris Elliottii ♃	6–8	yellow
2 Xyris fimbriata ♃	7–9	yellow
2 Dulichium arundinaceum ♃	7–8	—
2 Trilisa odoratissima ♃	8–9	purple

1	Lophiola aurea ♃	6–7	—
1	Panicum stenodes	6–9	—
1	Xyris neglecta	7	yellow
1	Xyris brevifolia ②	4	yellow
1	Eleocharis Robbinsii ♃	7–8	—
1	Rhynchospora ciliaris ♃	5–8	—
1	Rhynchospora distans ♃		—
1	Anchistea Virginica ♃	o	o
1	Eleocharis melanocarpa ♃	4–7	
1	Xyris sp. (1452) ♃	7–8	yellow
1	Centella repanda ♃	7–8	cream
1	**Lycopodium alopecuroides**	o	o
1	Rhexia filiformis	6–9	white
1	Xyris Baldwiniana ♃	6–9	yellow
1	Sophronanthe hispida ♃	7–9	white
1	Ludwigia suffruticosa ♃	7–8	cream
1	**Sphagnum Fitzgeraldi immersum**		
1	" **cuspidatum angustilimbatum**		
1	" **Garberi**		
1	" **Harperi**		

Summary. This flora has affinities with that of the shallow pine-barren ponds and with that of the intermediate sand-hills (and consequently more remotely with intermediate pine-barrens), but contains a few species not known elsewhere in the region.

The woody plants are mostly evergreen, as is often the case, and the herbs are nearly all perennial, as usual.[1]

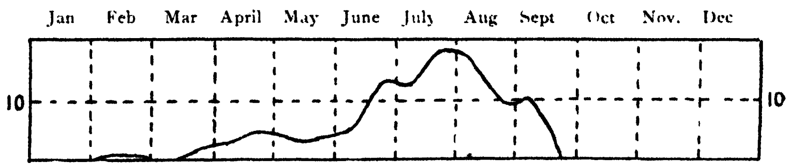

FIG. 14.

Phænological diagram for 30 plants of sand-hill ponds.

The number of flowers seems to culminate about the last of July, with 18 species in bloom, but decreases to none in September. The average flowering period is nearly as long as that of cypress ponds, namely, 53 days.

[1] For references to anatomical studies of *Ilex glabra* and *Dulichium arundinaceum* see the catalogue.

The colors of the flowers are distributed about as follows: anemophilous, white, and yellow, 8 each; cream, 4; purple, 2. Wind and resilient stems seem to be the principal agents for dissemination.

Xyridaceæ is the largest family in the list and *Xyris* therefore the largest genus. The fact that this list contains all the Lauraceæ and Cyrillaceæ of the Altamaha Grit region is interesting. This is the only habitat group in which dicotyledons are in the minority, and 48.6% of the angiosperms are monocotyledons. The total absence of anything between Cyrillaceæ and Hæmodoraceæ is striking.

There is no marked peculiarity about the ranges of these species. About half of them are confined to the pine-barren region.

17. Sand-Hammocks.

There are a few examples of sand-hills, which while having much the same aspect as others, have quite a different vegetation, consisting of more woody plants than herbs, and a considerable proportion of evergreens. The reason for this difference however is still a mystery. Such places are sometimes called sand-hammocks (plate XV, figs. 1 and 2), doubtless because of the resemblance of their flora to that of the hammocks (which will be discussed next). They must bear considerable resemblance to the "scrub" of Florida, from all accounts. The "rosemary" sand-hills of Emanuel County, which I visited in 1901[1], are a good example of sand-hammock, and there is a similar place on the Ohoopee River nearly opposite the mouth of Pendleton Creek in Tattnall County. The following species have been observed at these two places. (They are arranged in approximate order of abundance, as usual, but the frequency numbers are omitted, as they would be only either 1 or 2 in each case.)

Quercus Catesbæi	3	—
Quercus laurifolia	3	—
Magnolia grandiflora	5–6	cream
Ilex opaca	4–5	greenish
Pinus palustris	3	—
Osmanthus Americana		greenish

[1] See *Bull. Torrey Club*, **30**: 285. *f.* 2. 1903.

Batodendron arboreum	5	white
Hamamelis Virginiana	10–1	yellow
Asimina parviflora	3–4	dark purple
Ceratiola ericoides		
Quercus geminata	4	—
Polygonella Croomii	9	white
Polycodium cæsium	4	white
Clinopodium coccineum		red
Ilex ambigua		
Vitis rotundifolia	5	cream
Gelsemium sempervirens	3	yellow
Pieris nitida	3–4	white
Vaccinium sp.		
Castanea pumila		white
Amelanchier Canadensis		white
Persea pubescens		
Rhynchospora dodecandra ♃	5–6	
Paronychia herniarioides (1)	6–7	greenish
Stipulicida setacea (1)	4–7	white
Actinospermum angustifolium (1)	9	yellow
Arenaria Caroliniana	4–6	white
Smilax pumila	9	cream
Opuntia vulgaris	5–7	yellow
Jatropha stimulosa	4–9	white
Cuthbertia graminea	5–7	pinkish
Paronychia riparia	7–8	greenish
Cyperus echinatus ♃		
Aldenella tenuifolia (1)	6–8	white
Linaria Floridana (1)		

As most of these species grow also in the regular hammocks (see below) a detailed summary of their characteristics is hardly necessary here. We may note in passing that about half of the woody species are evergreen, and that there are more shrubs than herbs.

About one-third of these species are found also on sandy river-banks in the Lower Oligocene region.

18. Hammocks.

Hammocks have been briefly defined elsewhere (see page 26). In the region under consideration they are always situated at the foot of a sand-hill (plate XVI, figs. 1 and 2), and bordering the adjacent creek or river swamp, but in many cases the hammock is reduced to such a narrow strip as to be scarcely distinguishable. In a few places the streams cut into the sand-hills, forming bluffs without any swamp at their bases, and such bluffs usually have a hammock vegetation.

The soil of a hammock is the same Columbia sand as on the adjacent sand-hill, but mixed with more or less humus derived from the more luxuriant vegetation. Whether the underlying Lafayette is near enough to the surface in the hammocks so that roots of trees can reach it I am unable to say, but if it is, this would largely account for the nature of the vegetation. The hammock soil must also contain more water than that of the sand-hills, but it is never perceptibly moist at the surface (except of course in rainy weather). The boundary between sand-hills and hammocks is never very sharp, and it is altogether probable that the hammocks are tending to encroach on the sand-hills as the humus accumulates, just as the branch-swamps are probably encroaching on the moist pine-barrens, as already pointed out. Reasoning backward we may imagine a time, not long after this region emerged from the sea for the last time, when there were no hammocks at all. When we examine the ranges of the plants we will find evidence in support of this supposition.

The following species are characteristic of hammocks in the Altamaha Grit region.

8 **Quercus laurifolia**	3	—
9 **Osmanthus Americana**		greenish
7 **Magnolia grandiflora**	5–6	cream
6 **Ilex opaca**	4–5	greenish
5 Cornus florida	3–4	white
5 **Pinus glabra**	3	—
2 **Cholisma ferruginea**	5	white
2 Mohrodendron dipterum		white
2 **Persea pubescens**		
2 Hicoria sp.		—
2 **Quercus geminata**	4	—
1 Ostrya Virginiana	3–4	—
1 **Pinus Tæda**	3–4	—
1 Prunus serotina	3–4	white
1 **Prunus Caroliniana**	3	cream
9 Batodendron **arboreum**	5	white
8 Hamamelis Virginiana	10–1	yellow
4 *Vitis rotundifolia*	5	cream
4 Callicarpa Americana	6–7	purple
4 Asimina parviflora	3–4	dark purple
3 Rhus copallina	7–9	cream
3 **Serenoa serrulata**	6	cream
3 ***Gelsemium sempervirens***	3	yellow
3 Sebastiana ligustrina	6	greenish
2 *Parthenocissus quinquefolia*	5	greenish
1 **Symplocos tinctoria**	3–4	cream

1 Bumelia lanuginosa	7	cream
1 ***Bignonia crucigera***	3–5	red and yellow
1 Rhus Toxicodendron		cream
1 **Pieris nitida**	3–4	white
1 Clinopodium Carolinianum	9–10	pink
1 Castanea pumila	5–8	white
1 Viburnum rufotomentosum	4–5	white
1 **Ilex vomitoria**		
1 Amelanchier Canadensis	3	white
1 Ilex ambigua		
1 Euonymus Americanus	5–6	greenish
1 Polycodium cæsium	4	white
6 **[Dendropogon usneoides]**		
6 Rhynchospora dodecandra ♃	5–6	—
5 **Opuntia vulgaris**	5–7	yellow
4 **[Epidendrum conopseum]**	6–7	cream
3 **Smilax pumila**	9	cream
3 *Paronychia riparia*	7–8	greenish
3 **[Polypodium polypodioides]**	0	0
2 Siphonychia pauciflora	6–9	white
3 Cyperus echinatus ♃		—
2 Cyperus cylindricus ♃		—
2 Erythrina herbacea ♃	5	red
2 Scleria triglomerata ♃	5–6	—
2 Dicerandra linearifolia ①	9–10	white
2 Panicum Ashei	7	—
1 Indigofera Caroliniana	6–8	
1 Dicerandra odoratissima ①	9–10	white
1 ***Mitchella repens***	5	white
1 *Galactia regularis* ♃	6–7	purple
1 *Clematis reticulata* ♃	6–8	
1 Euphorbia cordifolia ①	9	greenish
1 Galium hispidulum ♃		greenish
1 Solidago Boottii ♃	9	yellow
1 Froelichia Floridana ①	7–8	white
1 **Tipularia discolor**	8	brown
2 **Thelia asprella**		
1 **[Schlotheimia Sullivantii]**		
1 (ELFVINGIA FASCIATA)		

Summary. Like the adjacent non-alluvial swamps, the hammocks are conspicuous for the prevalence of woody plants, and of evergreens, and there is not a great deal of difference between their winter and summer aspects. The trees are nearly as numerous as the shrubs, and there are about as many shrubs as herbs.[1] The proportion of vines and epiphytes is quite large, showing that the vegetation is becoming pretty highly specialized, in some ways at least. The herbs are mostly

[1] For references to anatomical studies of *Galium hispidulum*, *Gelsemium sempervirens*, *Symplocos tinctoria*, *Batodendron arboreum*, *Quercus laurifolia*, and *Dendropogon usneoides* see the catalogue.

perennial, and the few annuals have evidently crept in from the adjacent sand-hills.

Flowers are never very abundant or conspicuous in these places, but seem to be most numerous in the latter part of March. In this respect the hammocks are very different from the sand-hills, and more like the non-alluvial swamps. The average flowering period is 39 days. White flowers predominate (as in the swamps and on the sand-hills too), there being at least 15 white-flowered species. There are 11 species with anemophilous flowers, 9 greenish entomophilous, 10 cream-colored, 4 yellow, and one or two each of several other colors.

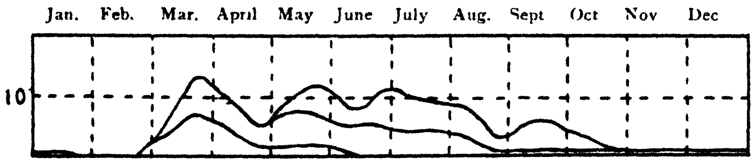

FIG. 15.

Phænological diagram for 50 plants of hammocks, including 11 trees and 21 shrubs.

Fleshy fruits are more common than any one other contrivance for dissemination. In *Hamamelis* we have a well-known case where the seeds are forcibly ejected from their capsules.

The ranges of the hammock plants are of considerable interest. Out of 58 species whose ranges are pretty well known, 14, or nearly one-fourth, grow almost anywhere in the Eastern United States, probably in all or nearly all the geological divisions described near the beginning of this paper. Twelve others have an equal disregard for geological formations in the southeastern states, but for some reason (climatic most likely) do not range farther north than Virginia. Nineteen species (about one-third) are confined to the coastal plain or nearly so, but not to the pine-barrens. About 13 others are confined (in Georgia at least) to the lower three-fourths of the coastal plain, which includes the pine-barrens and littoral region. Only 5 of these last 13 are not known northwest of the Altamaha Grit escarpment (and some of these belong more properly to other habitats than hammocks). These figures can be presented in another way. Over 90% of the

hammock flora ranges farther inland than the Altamaha Grit region, 78% grows in the upper fourth of the coastal plain (*i.e.*, in the Cretaceous and Eocene regions), and 45% crosses the fall-line. Most of the trees and shrubs are also characteristic inhabitants of rich woods in the Eocene region.

It is evident from these statistics that the species now inhabiting the hammocks have mostly come in from other places which are farther north and farther inland (and consequently cooler and more elevated). The fact that they tend to flower early, as already shown, is pretty good evidence that they range mostly toward cooler climates. As many of them are now also perfectly at home in places which were not submerged during the time that the Columbia sand was being deposited, they doubtless antedate that period, and are therefore older than the typical pine-barren species are supposed to be.

As the typical hammock plants have evidently arrived in the region under consideration since the sand-hills were formed, it is reasonable to suppose that others are still coming in, and that if unmolested the hammocks a few thousand years from now would be more extensive and have a richer flora than at present. It is an interesting fact that most of the hammock plants which have been noted in the region but once or twice are known only in the uppermost counties, as may be seen by consulting the catalogue of species. This alone would seem to indicate that they are still on their way toward the coast.

Taxonomically the list shows 65 species belonging to about 57 genera and 42 families. No family has more than four representatives, and no genus more than three. There are only 10 monocotyledons, which is about 17% of the total angiospermous flora of the hammocks.

19. River Bluffs.

The muddy rivers which traverse the Altamaha Grit region (*i. e.*, the three largest ones, which rise in the Piedmont region) are bordered in places by steep bluffs (plate XII, fig. 1), formed by erosion in much the same way as other bluffs the world over. These bluffs are best developed at or near the inland edge of our territory (where the Chattahoochee formation probably crops

out). The plants listed below have been observed on the Ogeechee River near Echo in Bulloch County (opposite Rocky Ford), on the Oconee at two places near Mount Vernon, and on the Ocmulgee at Upper Seven Bluffs in Wilcox County (see pages 17–18). A bluff on the Ocmulgee near Lumber City has about the same flora, but is not included in this enumeration because its geological structure is probably not exactly the same. These bluffs are the only examples in the Altamaha Grit region of the typical mesophytic forests which are so characteristic of the older parts of the continent. Like the hammocks just discussed they are characterized by abundance of shade and humus; and their flora may be regarded as a step farther removed from that of the pine-barrens than the hammock flora is, as will be seen from the following list.

5 Cercis Canadensis	3	purple
3 Cornus florida	3–4	white
2 **Magnolia grandiflora**	5–6	cream
2 **Ilex opaca**	4–5	greenish
2 Quercus alba	4	—
2 **Pinus Tæda**	3–4	—
2 **Pinus glabra**	3	—
1 Morus rubra	4	
1 Liquidambar Styraciflua	3	
2 **Pinus echinata**	4	—
1 Ostrya Virginiana	3–4	—
1 Quercus Michauxii		—
1 Liriodendron Tulipifera	4	cream
1 Quercus minor	4	—
1 Castanea pumila	5–8	white
4 Æsculus Pavia	3–4	red
3 Hamamelis Virginiana	10–1	yellow
3 Batodendron **arboreum**	5	white
3 *Parthenocissus quinquefolia*	5	greenish
3 Viburnum rufotomentosum	4–5	white
2 Chionanthus Virginica	4–5	white
2 ***Lonicera sempervirens***	4–6	red
2 *Vitis rotundifolia*	5	cream
2 Aralia spinosa	8	cream
2 Rhus copallina	7–9	cream
2 Ceanothus Americanus	5–6	white
2 Asimina parviflora	3–4	dark purple
1 Amelanchier Canadensis	3	white
1 Euonymus Americanus	5–6	greenish
1 *Vitis æstivalis*	5	cream
1 Clinopodium Carolinianum	9–10	pink
1 **Myrica cerifera**	3	—
1 Callicarpa Americana	6–7	purple
1 ***Bignonia crucigera***	3–5	red and yellow

1	Azalea nudiflora	3-4	pink
1	Rhus aromatica	3	
1	Alnus rugosa	1-2	—
3	**Polystichum acrostichoides**	0	0
3	**Asplenium platyneuron**	0	0
3	*Phaseolus polystachyus* ♃	6	purple
2	*Dioscorea villosa* ♃	4-7	cream
2	[**Dendropogon usneoides**]		
2	***Mitchella repens***	5	white
2	Meibomia nudiflora ♃	6-8	purple
2	**Smilax pumila**	9	cream
2	Houstonia longifolia ♃	5-11	purple
2	Asplenium Filix-fœmina ♃	0	0
2	Spigelia Marilandica ♃	5	red and yellow
2	Zizia Bebbii ♃		
2	Scleria triglomerata ♃	5-6	—
2	Salvia lyrata ♃	4-5	blue
1	Galium uniflorum ♃	4-5	greenish
1	Pentstemon hirsutus	4-6	purple
1	Sanicula Marilandica ♃	5	cream
1	Podophyllum peltatum ♃	3-4	white
1	(Conopholis Americana) ♃	3-4	brown
1	Uniolia latifolia ♃		—
1	Verbesina Virginica ♃	0	white
1	Scutellaria Mellichampii	6	blue
1	*Meibomia Michauxii* ♃		purple
1	Panicum barbulatum ♃	6	—
1	Thalictrum macrostylum ♃	6	
1	Pteridium ♃	0	0
1	Euporbia corollata ♃	4-11	white
1	Melica mutica	3-4	—
1	Sanguinaria Canadensis ♃	3	white
1	Asclepias variegata ♃	5-6	white
1	Stipa avenacea ♃	4-5	—
1	Aristolochia Serpentaria ♃		

Summary. All the plants in the above list do not have exactly the same habitat, for the amount of shade and moisture varies on different bluffs and on different parts of the same bluff; but the differences in habitat are probably not great enough to introduce any serious error into the generalizations which follow.

This flora is comparable only with that of the hammocks just discussed. Just about one-third of the species on the bluffs are common to the hammocks, as far as known, and future discoveries probably will not change this proportion much.

Woody plants are more numerous than herbs, as in the hammocks, but on the bluffs, unlike the hammocks, evergreens are in the minority. Vines are quite numerous, and there are a few

epiphytes and parasites. The herbs are probably all perennial. Broad thin leaves and other "mesophytic" adaptations are of course the rule here.[1]

The flowering season seems to reach its height in spring, as in mesophytic forests nearly everywhere, and there are few flowers on the bluffs after the middle of the year. (See diagram.) The average flowering period is 40 days. The proportions of the various colors of flowers are much the same as in the hammocks.

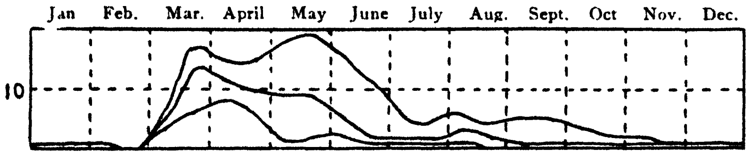

FIG. 16

Phænological diagram for 60 plants of river-bluffs, including 14 trees and 22 shrubs.

There are 12 anemophilous species, 13 white-flowered, 9 cream, 7 purple, 4 greenish, 4 red (some of these with yellow limb to the corolla), and a few yellow, pink, blue, and brown. The four red flowers all happen to have tubes about two inches long, and perhaps they are all pollinated by the same insect, or by humming-birds.

Fleshy fruits (in 22 species) greatly outnumber all other modes of dissemination. Nine or ten species have seeds transported by the wind, and five or six have adhesive fruits.

A systematic list would show 69 species in 61 genera and 44 families, which is very near the corresponding figures for the hammocks. The four largest families in the list, Leguminosæ, Cupuliferæ, Gramineæ, and Polypodiaceæ, have four representatives each. The two largest families in the whole Altamaha Grit region (and probably in the whole coastal plain as well), Cyperaceæ and Compositæ, are each represented on the bluffs by a single species. The Orchidaceæ seem to be entirely absent, which is rather surprising. The proportion of monocotyledons

[1] For references to anatomical studies of *Lonicera*, *Batodendron*, *Liquidambar*, *Podophyllum*, *Myrica cerifera*, and *Dendropogon* see the catalogue of species.

(less than 13% of the angiosperms) is smaller than in any other habitat-group here discussed.

A study of the ranges of these plants brings out some interesting facts. Quite a number do not extend farther into the Altamaha Grit region than its very edge, but without exception they all range farther inland. Only six species, *Scutellaria Mellichampii*, *Magnolia grandiflora*, *Myrica cerifera*, *Smilax pumila*, *Dendropogon usneoides*, and *Pinus glabra*, seem to be confined to the coastal plain. All the rest (over 90% of the whole list) therefore occur above the fall-line, and most of them grow nearly all over the Eastern United States, a large proportion finding congenial homes in the cool shaded valleys of the Blue Ridge.[1] All this goes to show that the bluff-inhabiting species are pretty old geologically, probably as old as any now living in this part of the world. It is easy to imagine how they have crept down along the rivers into the coastal plain as that territory gradually emerged from the sea the last time, after the close of the Pleistocene period.

These river-bluffs evidently represent the extreme of mesophytic conditions for the pine-barren region. It is noteworthy that *Fagus Americana*, which Dr. Cowles considers the most typical mesophytic tree of Eastern North America, does not yet occur on these bluffs, or anywhere else in the Altamaha Grit region, as far as known. It does occur however nearly everywhere farther inland, and comes to the very edge of our region in Decatur County at Forest Falls and along the escarpment from Faceville westward, where the Chattahoochee formation crops out. These places, and the vicinity of the Rock House in Dooly County, where the geological conditions are doubtless similar, (see page 17) have about the same kind of vegetation as the river-bluffs, with most of the same species.

Statistics of the Typical Habitat Groups.

In the appended table are given in condensed form some of the numerical statistics already elaborated for the 19 typical

[1]Their tendency to range northward is pretty well illustrated by the frequency of such specific names as *Americana*, *Canadensis*, *Marilandica*, and *Virginiana*.

habitat-groups, and scattered through the summaries. The figures in the first column represent the percentage of the whole area of the Altamaha Grit region supposed to be occupied by each habitat; and those in the second the percentage of the total native flora included in each. Columns 3 to 5 show the relative proportions of trees, shrubs, and herbs among the species of

Habitats	Per cent of		Per cent of							
	Area	Flora	Trees	Shrubs	Herbs	Families	Genera	Species	Per cent of Monocotyledons	Flowering period (days)
1. Rock outcrops	0.01	6.4	9	14	77	28	41	44	24	52
2. Dry pine-barrens	50.	17.3	5	15	82	37	100	136	16	49
3. Intermediate pine-barrens	10.	12.3	3	15	82	33	70	98	22	45
4. Moist pine-barrens	14.	23.4	2	11	87	46	105	187	44	49
5. Branch-swamps	6.	10.3	12	24	64	42	63	78	30	48
6. Creeks and small rivers	4	8.1	24	32	44	41	47	54	35	44
7. Rivers of 2nd class	1	5.8	43	34	25	28	33	44	26	37
8. Muddy rivers	2.	8.0	29	25	46	38	49	61	23	39
9. Cypress ponds	1	6.5	8	13	80	26	37	51	40	55
10. Shallower ponds	0.1	7.5	5	12	83	26	51	60	38	53
11. Escarpment ponds	0.01	3.5	11	19	70	19	24	27	42	
12. Sand-hills	8	17.0	5	15	80	45	103	133	18	51
13. Intermediate sand-hills	0.1	4.0	3	34	63	21	28	32	37	
14. Sand-hill bogs	0.5	7.0	11	26	63	32	45	54	35	43
15. Non-alluvial swamps	1	4.8	32	41	27	18	20	22	32	
16. Sand-hill ponds	0.02	5.3	5	34	61	20	30	38	40	53
17. Sand-hammocks	0.05	4.3	14	49	37	26	31	35	12	44
18. Hammocks	1.	8.1	24	37	39	41	54	62	17	39
19. River-bluffs	0.3	8.6	22	32	46	44	61	69	13	40

vascular plants. (The three cases where these figures add up more than 100 are where one species occurs both as a tree and a shrub.) Columns 6 to 8 show the number of families, genera, and species of vascular plants. Column 9 gives the percentage of monocotyledons among the angiosperms, and the tenth and last column the average duration of the flowering period, in days.

The accuracy of the figures for each group is of course approximately proportional to the number of species included. The figures for flowering period are omitted in three cases where the

number of species was so small that the results which would have been obtained by the usual method might have been misleading.

Some of the interesting facts brought out by the above table are as follows. Dry pine-barrens cover the greatest area and moist pine-barrens have the richest flora. Moist pine-barrens have the smallest proportion of trees and shrubs and consequently the largest proportion of herbs. The swamps of rivers of the second class have the smallest proportion of herbs and by far the largest proportion of trees. The largest proportion of shrubs is found in sand-hammocks, with non-alluvial swamps second. Sand-hill ponds have the largest percentage of monocotyledons, with moist pine-barrens next, and the three last groups the smallest. Cypress ponds, shallower pine-barren ponds, and sand-hill ponds seem to have the longest flowering periods, and river-swamps, hammocks, and bluffs the shortest.

In general the smallest percentages of monocotyledons and the shortest flowering periods belong to those groups a large proportion of whose members range inland to the Piedmont region and mountains, while the typical coastal-plain habitats have many monocotyledons and longer flowering periods. Investigations of this kind will perhaps hereafter throw a great deal of light on the origin and age of the flora of various other parts of Eastern North America.

It will be noticed that the percentages in the second column add up 168.2. This gives an idea of the extent of overlapping of the different habitat-groups. If the number of species common to two or more habitats decreases in geometrical progression with the number of habitats, which is not an unreasonable supposition, then about 60% of the species would be confined to one habitat each, 24% to two, 10% to three, 4% to four, and so on.

Relations of the Typical Habitat-Groups to Each Other.

Having completed a preliminary outline of the habitat-groups which may be considered fairly typical of the Altamaha Grit region, in which outline they have been treated in linear sequence, it will be appropriate to pause at this point and show their re-

lations to each other in two dimensions, by means of the conventional diagram appended.

In this diagram the units are represented by circles. These are connected by three kinds of lines (the lengths and directions of which have no significance). A double line indicates contiguity

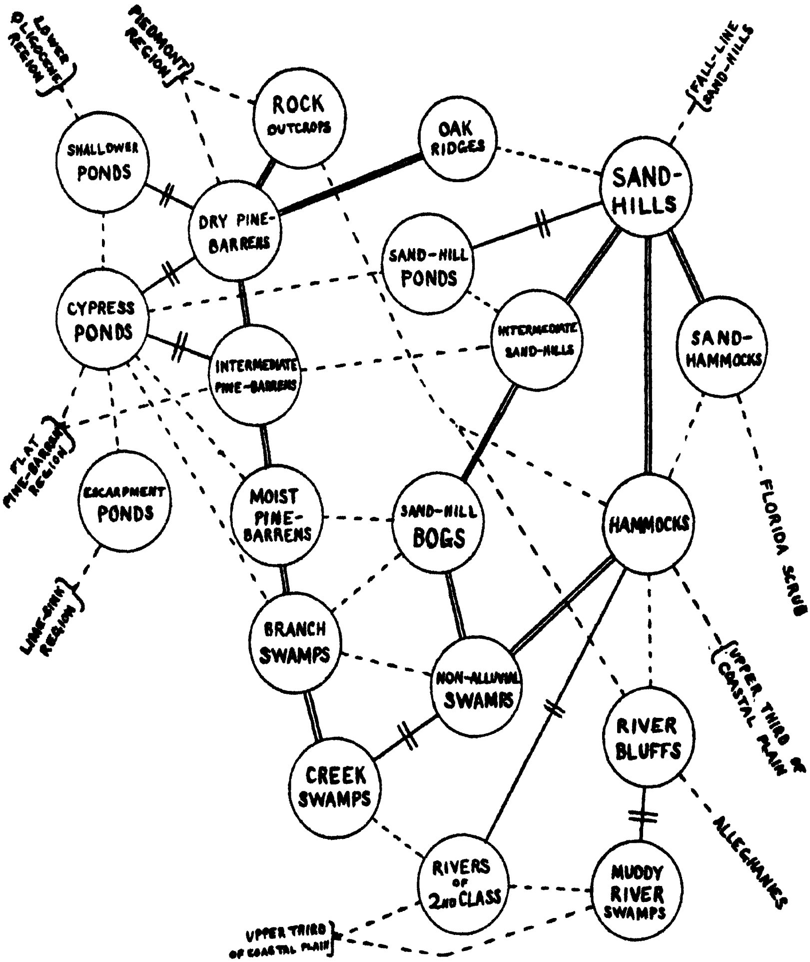

FIG. 17.

Conventional diagram showing relations of the principal habitat-groups to each other to some other parts of the Southeastern United States.

of two habitats, with more or less intergradation and several or many species in common. A dotted line indicates several species in common without contiguity, and a single continuous line with two marks across it indicates contiguity with few or no species in common.

In nature all these areas are bordered by transition zones, which are usually too narrow to have any species confined to them and have therefore been ignored. Of course several of the typical habitat-groups partake more or less of the nature of transitions between those on either side, but all those here recognized contain some characteristic species.

Around the edges of the diagram the dotted lines leading off in various directions indicate affinities of certain habitat-groups with others outside of the Altamaha Grit region, as have already been pointed out in the detailed descriptions.

Some Exceptional Habitats.

There remain to be considered a few classes of habitats in the Altamaha Grit region which are known as yet only from single examples. Although it is not yet possible to generalize much concerning these, some of them are so peculiar that they deserve mention, and if other examples of them are discovered hereafter they can then perhaps be properly classified.

The most striking of these exceptional habitats occur in the northwestern corner of Berrien County, within a few miles of Tifton, and were visited the last week in September, 1902. About three miles west of Tifton there is a small area of damp shady woods, containing the following species:

Cercis Canadensis
Magnolia grandiflora
Liquidambar Styraciflua
Liriodendron Tulipifera
Morus rubra
Acer rubrum
  Nyssa Ogeche
  Arundinaria sp.
  Myrica cerifera
  Decumaria barbara
  Chionanthus Virginica
  Hamamelis Virginiana
  Baccharis halimifolia
    Osmunda regalis ♃
    Helenium autumnale

Dioscorea villosa ♃
Iris versicolor ♃
Mesadenia Elliottii ♃
Mesosphærum radiatum ♃
Cynoctonum Mitreola
Rudbeckia foliosa ②
Ludwigia microcarpa
Eupatorium perfoliatum ♃
Selaginella apus
Eryngium Virginianum ♃
Elionurus tripsacoides ♃

About a mile and a half southwest of Tifton, in dense woods along a small branch, are the following:

Magnolia grandiflora
Quercus **nigra**
Liquidambar Styraciflua
Myrica cerifera
Decumaria barbara
Pieris nitida
Asimina parviflora
Vitis rotundifolia
Parthenocissus quinquefolia
Rubus nigrobaccus
Aralia spinosa
Rhus copallina
Sabal glabra
Itea Virginica
Callicarpa Americana
Smilax pumila
Mitchella repens
Osmunda regalis ♃
Helenium autumnale
Dryopteris Floridana
(*Cuscuta compacta*) ①
Pteridium ♃
Panicum Currani ♃
Osmunda cinnamomea ♃
Elephantopus nudatus ♃
Arisæma triphyllum ♃
Panicum Tennesseense ♃
Viola primulæfolia ♃
Botrychium obliquum ♃
[**Schlotheimia Sullivantii**]

About a mile southwest of this there is a small area of what appears at first glance to be ordinary moist pine-barrens, but its flora is more like that in the two preceding lists (particularly the first) than that of the moist pine-barrens previously discussed. The following species were noted there.

Pinus Elliottii
Taxodium imbricarium

Pinus serotina
- Rhus radicans
  - Rudbeckia foliosa ②
  - Erianthus strictus ♃
  - Ludwigia microcarpa
  - Iris versicolor ♃
  - Dichromena colorata ♃
  - Helenium autumnale
  - Eryngium Virginianum ♃
  - Boltonia diffusa
  - Manisuris rugosa ♃
  - Elionurus tripsacoides ♃

About another mile farther on in the same direction, between the sand-hills and swamp of Little River, is another peculiar piece of rich woods, but I have not enough notes on its flora to give a list here. (*Chimaphila maculata* grows there, among other things.)[1]

These three lists combined contain 57 species representing 53 genera and 35 families: Compositæ, with seven species, being the largest family. Just about one-fourth of the species have not been observed anywhere else in the Altamaha Grit region. The remainder mostly grow in hammocks or on river-bluffs, or a few in swamps of various kinds. Their ranges present no marked peculiarities, except that, as in the case of hammocks and bluffs, more of them range northward than coastward. But seven or eight of them are reported from the West Indies or other parts of tropical America, which is rather significant.

A large proportion of the species are known to have a decided fondness for limestone, and the conclusion is irresistible that there is some geological peculiarity about these spots where they grow. It is extremely likely that the Lafayette formation is absent here, and possibly the Altamaha Grit also, allowing the underlying calcareous formations to approach the surface. This conclusion is strengthened by the fact that many if not most of these plants grow also in places where the Lafayette and Grit are evidently absent. A moist thicket in the Lower Oligocene region near Leslie contains a flora very similar to that enumerated in the first of these three lists, and probably for the same reason. Just why the calcareous strata should be so near the surface in these places is not clear, for there is apparently no topographic

[1]See *Bull. Torrey Club*, 31: 24. 1904.

peculiarity which would account for it. The places are neither on hilltops or steep slopes nor in deep valleys, but their proximity to each other is doubtless significant.

In various other parts of the region are small areas of wet woods having a flora somewhat intermediate between the above and that of the common branch-swamps, but these are not yet very well understood.

On a hillside sloping toward the swamp of the Ocmulgee River in the northeastern corner of Coffee County opposite Lumber City, and about a mile from the river, is a peculiar moist belt extending horizontally along the hillside for some distance, marked by a dense growth of shrubs, chiefly *Alnus rugosa*. Following this same belt to a railroad cut near by, it was found to be connected with a stratum of Altamaha Grit there exposed. There may be other similar places in the region, but I have not yet come across them.

The Big Pond in Appling County (mentioned in a previous paper[1]) is another interesting feature, probably unique for the Altamaha Grit region. What little I could see of the vegetation around its edges resembles that of sand-hill bogs and non-alluvial swamps. What may grow in the pond itself is entirely unknown.

The occurrence of a few "bottomless" ponds, usually called lime-sinks by the natives, in the Altamaha Grit region has been mentioned above. The only example of this that I have seen (one in Coffee County) contained no floating plants, and the vegetation around its edges (trees, shrubs, and herbs), resembled that of a branch-swamp more than that of any other kind of pond It was surrounded at least in part by moist pine-barrens. Further study of these places is needed.

The sandy west bank of the Ohoopee River near the center of Tattnall County, opposite the sand-hills and near some of the rock outcrops already mentioned, has a flora resembling in part that of sand-hills, hammocks, and rock outcrops, but with few if any species peculiar to it. Somewhat similar conditions are met with along the Ocmulgee River opposite Lumber City.

This about completes the classification according to habitat of

[1] *Bull. Torrey Club*, **32**: 150, 151. 1905.

the *native* vegetation of the Altamaha Grit region, representing it as it might have appeared a hundred years ago or more, before civilized man began to tamper with it. There now remain to be considered the

Weeds.

"Weed" is here used to denote a plant which is believed not to be indigenous in the region, whether it is detrimental to the interests of civilized man or not. The weeds of the Altamaha Grit region are principally confined to yards, roadsides, and railroads. (Plate XVII, Fig. 1.) Very few of them invade cultivated fields, and none encroach on the territory of the native plants except where the latter have been destroyed or weakened by civilization. Weeds at present constitute about 10% of the total number of species in the region, but probably only a minute fraction of 1% of the number of individuals. In other words, most of them are not at all abundant.

In the following list the species are arranged in systematic sequence (in the same order as in the taxonomic part of this work). After the name of each is its frequency number, and then the region where the species is believed to have originated. No attempt is made to indicate duration, time of flowering, etc., as was done in the treatment of the native plants. All but two of them are herbs, and probably mostly annuals.

Erechthites hieracifolia	1	North America?
Achillea Millefolium	5	Europe?
Anthemis Cotula	5	Europe
Helenium tenuifolium	∞	Mississippi Valley?
Bidens bipinnata	1	Mexico?
Acanthospermum australe	∞	Tropical America
Gnaphalium purpureum	2	North America?
" obtusifolium	1	Eastern U. S.?
Leptilon Canadense	2	North America?
Erigeron ramosus	1	" "
Isopappus divaricatus	3	Central U. S.?
Iva microcephala	6	Southern U. S.?
Ambrosia artemisiæfolia	2	North America?
Xanthium strumarium	1	" "
Specularia perfoliata	1	" "
Sambucus Canadensis	1	" "
Diodia teres	17	Eastern U. S.?
Richardia scabra	1	Tropics
Plantago aristata	2	Central U. S.?
Veronica peregrina	1	Europe?
Scoparia dulcis	1	Tropics

Ilysanthes gratioloides	1	Northern Hemisphere
Linaria Canadensis	6	North America?
Verbascum Thapsus	1	Europe?
" Blattaria	1	"
Perilla frutescens	1	Asia
Verbena bracteosa	2	Central U. S.?
Solanum nigrum	1	Cosmopolitan
" Carolinense	3	Eastern U. S.?
" rostratum	3	Central U. S.
Datura Tatula	2	South America?
" Stramonium	1	Old World Tropics?
Polypremum procumbens	2	West Indies?
Daucus pusillus	1	Central U. S.?
Spermolepis divaricatus	4	" "
Œnothera laciniata	3	Mexico
Passiflora incarnata	2	Tropics?
Helianthemum rosmarinifolium	2	Westward?
Sida rhombifolia	2	Tropical America
Euphorbia maculata	8	Eastern U. S.?
Croton glandulosus	1	Tropical America
Lespedeza striata	14	Eastern Asia
Trifolium repens	2	Europe
Cassia Tora	1	Tropics
" occidentalis	2	"
Prunus angustifolia	4	Westward?
Lepidium Virginicum	4	North America ?
Coronopus didymus	1	Europe?
Nymphæa orbiculata	1	Lime-sink regions of Ga. and Fla.
Sagina decumbens	1	Eastern U. S.?
Portulaca pilosa	3	Tropics
Mollugo verticillata	1	Tropical America?
Boerhaavia erecta	1	" "
Alternanthera repens	2	Tropics
Chenopodium ambrosioides	1	"
Rumex hastatulus	3	Central U. S ?
Juncus bufonius	1	Cosmopolitan
Mayaca fluviatilis	1	Florida mostly
Stenophyllus Floridanus	15	?
Fimbristylis laxa	1	Tropics?
Cyperus compressus	3	Tropics
" squarrosus	1	"
Lipocarpha maculata	2	Tropics?
Hordeum nodosum	1	Europe?
Festuca octoflora	2	Tropics?
Eragrostis amabilis	6	Asia
" ciliaris	1	Tropics
" simplex	11	?
" refracta	1	S. E. U. S.?
Eleusine Indica	4	Tropics
Capriola Dactylon	1	"
Cenchrus tribuloides	1	Tropics?
Panicum cognatum	1	Central U. S.?
Echinochloa colona	1	Tropics
Syntherisma sanguinale	4	"
Anastrophus compressus	1	"
Marchantia polymorpha	1	Cosmopolitan

Summary. The commonest weeds are *Helenium*, *Acanthospermm*, *Diodia teres*, *Stenophyllus Floridanus*, *Lespedeza striata*, *Eragrostis simplex*, *Euphorbia maculata*, and *Syntherisma*, approximately in the order named. Three of these, *Helenium*, *Acanthospermum*, and *Lespedeza*, are known to have come into Georgia since the recollection of some of the older inhabitants, one from the west, one from tropical America, and one from Asia.[1] Two others, *Stenophyllus* and *Eragrostis*, are definitely known only from Georgia and Florida, and have been described only within the last ten or twelve years, but they can hardly be native in this country. The other three, *Diodia*, *Euphorbia*, and *Syntherisma*, are so common in the Eastern United States that they are often considered indigenous. Most of the other weeds in the whole list have been noted but once or twice in our territory.

Compositæ and Gramineæ are the largest families in the above list, but a larger proportion (100%) of our Ambrosiaceæ and Solanaceæ, and several families represented by a single species each, are weeds. *Solanum* and *Eragrostis* are the largest genera in the list, and it is noteworthy that they have no native representatives in our territory.

As for the ranges of these weeds, quite a number are not known outside of North America, but it is difficult to imagine what their habitats could have been before the country was settled. (This class of supposed native weeds is doubtless much larger in almost all other parts of the country.) In such cases one is almost forced to the conclusion that the species have originated (by mutation or otherwise) since the discovery of America. Of those whose origin is known the majority came from the tropics, but some of them are probably just as much weeds there as here. Several are probably natives of the western plains and prairies, and a few came from Europe with the early settlers.[2]

[1] Dr. H. A. Mettauer, the veteran botanist of Macon, tells me that he can remember when *Lespedeza striata* first appeared there, and that it came in the shape of packing around some Chinese or Japanese crockery.

[2] Compare this list of weeds with one for Sumter County in *Bull. Torrey Club* **27**: 421. 1900.

For pollination about 21 species have anemophilous flowers, 22 white, and 10 yellow. Other colors are less frequent. It is surprising how little is known about the dissemination of even the worst of these weeds, and it is a mystery how the eight commonest ones above mentioned have spread over so much territory. About eight species in the whole list have wind-borne seeds, seven adhesive, and five fleshy fruits.

The enumeration of weeds naturally leads to a discussion of other

Effects of Civilization.

Most of the descriptions in the foregoing pages, up to the beginning of the weed list, would have been equally true a hundred or even a thousand years ago. But civilized man now apparently threatens the ultimate destruction of all vegetation, and even in a thinly settled country like the wire-grass region of Georgia the effects of civilization are far-reaching and cannot well be ignored.

The greatest damage to native vegetation, amounting in most cases to total destruction, is of course caused by clearing the land for cultivation or for buildings. In the Altamaha Grit region at present probably not over 5% of the total area has suffered in this way. This is in marked contrast with Middle Georgia and the Cretaceous and Eocene regions of South Georgia, where the population is much denser and nearly all the land which is not too steep or too wet or too rocky has already been cleared and cultivated at some time or other.

The next greatest injury is done by lumbermen in removing the pine trees (lumbering in this region being almost exclusively confined to pine). A pine-barren area which has been cut over with the present wasteful methods presents a desolate appearance for years afterward. (Plate XVII, Fig. 2.) But fortunately this has little effect on the shrubs and herbs, for the amount of light which they receive is not appreciably increased by removing the trees, and there is never any such succession of different vegetation after lumbering as is the rule in the denser forests farther inland.

The turpentine operators do about as much damage as the lumbermen. Probably nine-tenths of the specimens of *Pinus*

palustris and *P. Elliottii* now standing in South Georgia have been bled by them. Under the common system of turpentining (since 1902 being slowly superseded by an improved system invented by Dr. C. H. Herty), each tree is usually worked only three years, and the operators try to get as much as possible out of it in that length of time, without any regard for the future. After the turpentine men are through with the trees (or even before), many of them are blown over by the wind or destroyed by fire. The improved system greatly prolongs the life of the tree and lessens the danger from wind and fire, but it came too late to save many of the present generation of pines in Georgia.[1]

The stock-raisers, with their thousands of cattle and sheep which roam through the pine forests almost as freely as on the western plains, living principally on wire-grass, contribute to the destruction of the forests in two ways, grazing and burning. Grazing alone seems to do little if any damage to the pine forests. But the fires which are (and have been for several centuries, it is said) started every winter or spring in order to burn off the dead leaves of the wire-grass so that the cattle can more readily get at the new growth, are a more serious matter. These fires (plate XVIII, fig. 2.) are of course mostly confined to the dry pine-barrens, but in very dry weather they may burn well down toward the swamps and even through cypress ponds. On sand-hills there is practically no grass to burn, and the dead leaves probably do not accumulate there fast enough to allow of a fire every year.

Too frequent fires, although they seem to do no harm to the mature and sound pine trees (which are unfortunately rare now), prevent the young ones from getting a start and play havoc with those that have been turpentined. Opinions differ as to the effect of annual fires on the herbaceous vegetation, but it seems to me that the damage done must be comparatively slight. The whole dry pine-barren flora seems adapted to stand occasional fires, which must have often been started by lightning even before the earth was inhabited by man. Even if fire were kept

[1] The relative merits of the different systems of turpentining are fully discussed and illustrated by Dr. Herty in Bulletin 40 of the Bureau of Forestry, U. S. Dept. Agriculture. His field experiments were all carried on in the Altamaha Grit region.

out of the pine-barrens for a hundred years it is not likely that the composition of the flora would change perceptibly, as may be inferred by comparing a pine-barren area burned over within a few months with one which has not been burned for several years. The Lafayette and Columbia formations have hardly had time yet to produce the type of forests with abundant shade and humus which are familiar in most parts of the civilized world. If such forests were capable of developing where dry pine-barrens are now they would doubtless have done so centuries ago, and fire would hardly have gotten a foothold in them. Opinions are divided even among the natives of the wire-grass country as to the desirability of burning off the grass every year, but those who believe in this ancient practice usually act accordingly, and the others are powerless to stop it.

Man has also exerted a profound influence on the flora by destroying many of the native birds and quadrupeds which formerly carried seeds from place to place, and introducing domesticated and foreign species in their stead. The partial extermination of the native birds (which mostly take place in other parts of the country but is felt everywhere because they migrate) disturbs the equilibrium in another way by allowing injurious insects to increase. Again, the introduction of the honey-bee must have some tendency, however slight, to modify the shape of the native flowers on which it works.

Another adjunct of civilization, in Georgia confined to the coastal plain, and having a slight but perceptible influence on the vegetation, is the artesian well. These wells are becoming quite numerous, and they evidently create new streams and increase the flow of others. The removal of a large part of the forests in the Piedmont region has greatly increased the amount of sediment carried by the larger rivers, and probably modified the flora of their swamps to some extent.

The remarkable stability of the pine-barren flora, as compared with that which is familiar to most inhabitants of the United States, is shown by the fact that after lumbering, after fire, and even after cultivation, the same vegetation tends to reappear in a comparatively short time, almost without pre liminary stages such as have been described in recent years by

many writers in the north; all of which goes to show that the pine-barrens represent a pioneer type. There is one slight exception to this. *Pinus Elliottii* sometimes takes possession of land from which *Pinus palustris* has been removed, and this has led some writers on forestry to believe that the latter species was becoming extinct and the former taking its place. Even the natives commonly believe that the long-leaf pine does not reproduce itself after lumbering, but metamorphoses into the other species (the "slash pine"). But in reality the succession of *P. Elliottii* after *P. palustris* is the exception rather than the rule, at least in the Altamaha Grit region, and has doubtless been exaggerated. In their natural condition the habitats of these two pines are entirely distinct, and if the whole region could be let alone for fifty or a hundred years the equilibrium would doubtless be in large measure restored.

All things considered, however, there is probably at the present writing no part of the world more favorably situated for phytogeographical study than the Altamaha Grit region, with its great accessibility,[1] salubrious climate, and freedom from many of the evils of modern civilization which characterize the more densely populated parts of the country. But with the population increasing 5% a year (which means doubling in 15 years) there is danger that some types of vegetation will disappear entirely before they can be sufficiently studied. At present the damage has been chiefly confined to the dry pine-barrens, but there is no telling when the rocks, swamps, and sand-hills will begin to be sacrificed to commercialism.

[1] Railroad mileage seems to be increasing faster there than anywhere else in the Eastern United States, and the destructive effects of civilization are hardly keeping pace with it.

PART II.

HISTORY OF BOTANICAL EXPLORATION OF THE ALTAMAHA GRIT REGION.

Before enumerating the known flora of the region a sketch of the explorations on which our knowledge of it is based will be in order.

Probably the first explorer to visit the region under consideration was Hernando DeSoto, who with a large party entered what is now Georgia at its southern border in the spring of 1540, and proceeded northward toward the mountains, probably leaving the state somewhere near its northwest corner. But DeSoto was looking mainly for gold, and the descriptions of geographical features in the extant narratives of his expedition are so vague and infrequent that it is impossible to trace his route through South Georgia with any degree of accuracy. The "deserts" mentioned by his chroniclers were doubtless pine-barrens,[1] but nothing is said about their vegetation.

After DeSoto's memorable but ill-fated expedition nearly 200 years seem to have elapsed before South Georgia was again explored. The colony of Georgia was founded by Oglethorpe at Savannah in 1733, and the new settlers soon pushed inland from there into the new country, some going up the Savannah River to the fall-line, where they established the city of Augusta, and others migrating southward along the coast. From Augusta a chain of settlements gradually extended westward along the fall-line, but the interior of South Georgia, including the pine-barrens, was long avoided, because it was considered almost a desert. Catesby and John Bartram, who were in Georgia about the time of Oglethorpe or a little later, probably did not go into the Altamaha Grit region, for it was then uninhabited, or nearly so. William Bartram, in 1773 and a few subsequent years, and André Michaux and his son about 14 years later, passed more than once

[1] For this interpretation I am indebted to the first chapter of Joel Chandler Harris's *Stories of Georgia*, a small popular historical treatise published in 1896.

over the roads between Savannah and Augusta, and probably crossed the eastern end of the Grit in what is now Screven County. Both Bartram and Michaux noted there an unfamiliar shrub which must have been *Cliftonia*, one of the most characteristic plants of the region.

In the last decade of the 18th century John Abbot, an English artist and entomologist, was making the drawings for his *Natural History of the Rarer Lepidopterous Insects of Georgia* (edited by Sir J. E. Smith and published in London in 1797), and he seems to have worked principally if not entirely in the counties of Screven (laid off in 1793) and Bulloch (laid off in 1796), though not altogether in the Altamaha Grit region.[1] Besides a few new species figured by Abbot and described by Smith, he was also the discoverer of *Sabbatia gentianoides* Ell., which came from Bulloch County.

Early in the 19th century Œmler, Baldwin, Elliott, and Beyrich must have crossed the eastern end of the Altamaha Grit country at about the same place where Bartram and Michaux did, but they do not seem to have published any notes on it.

About 1830 Nuttall was in Tattnall County (established in 1801), and discovered there *Arenaria brevifolia* and a *Sarracenia* which he took to be new.[2] And in his *Sylva of North America*[3] he mentions having found *Cliftonia* at the same place where Bartram did. This seems to be all that is on record about his travels in the Altamaha Grit region.

About the same time Croom, on his semi-annual journeys from North Carolina to Florida, must have passed through or close to the inland edge of the region (somewhere between Louisville and Hawkinsville), for he mentions finding at least one plant (*Pentstemon dissectus*) which is not known elsewhere. (James Jackson,

[1] The drawings mostly represent plants which can now be found in those counties, and there is other evidence about the time and place of some of Abbot's subsequent work, in Darlington's *Reliquiæ Baldwinianæ*. Also in White's *Statistics of Georgia* (1849), under the head of "Instances of Longevity" in Screven County, is a statement that "Mr. Abbot lived to an advanced age."

[2] See *Torreya* **4**: 140. 1904.

[3] **2**: 93. 1846.

who discovered this species, must have gone into the region somewhere to get it. See *Bull. Torrey Club* **32**: 166, 167. 1905; *Torreya* **5**: 183, 184. 1905).

Since the era of railroads several well-known botanists have passed through portions of the Altamaha Grit country without being aware of the fact, or stopping to make any notes or collections. Among these were Canby in 1869, Gray in 1875, Kearney in 1893 and 1895, and Small in 1895.

Of botanists now living, Prof. S. M. Tracy seems to have been the first to make any collections in this region. In the summer of 1890 he spent a short time in Southwest Georgia, and made a considerable collection, principally of grasses and sedges, for the U. S. Department of Agriculture, near Cycloneta (Irby P. O.) in Irwin County. These specimens are now in several of the leading herbaria of the country, but none of them that I have seen are accompanied by any indication of habitat. At least one (*Eryngium Ludovicianum*) has already been cited in botanical literature.[1]

In 1893 Dr. Charles Mohr, while doing some field work for the Division of Forestry of the U. S. Department of Agriculture, collected a few specimens in Dodge County near Eastman, among them *Gerardia divaricata* (?), *Dicerandra linearifolia*, and *Clinopodium Carolinianum*.

On August 14, 1900, Messrs. C. L. Pollard and W. R. Maxon, from the U. S. National Herbarium, entered the Altamaha Grit region for a short distance in Worth County, collecting a few specimens near Poulan. Up to the present writing these do not seem to have been distributed, but one of them, *Eryngium Ludovicianum*, was cited at the same place as Prof. Tracy's specimen of the same species.

Mr. A. H. Curtiss of Jacksonville, Fla., has done considerable work in Georgia, particularly on his last trip through the state, in 1901. From June 24 to 27 of that year he was in Berrien and Coffee Counties, collecting *Panicum erectifolium* (no. 6817), *Xyris Baldwiniana* (no. 6818), *Lobelia Boykinii* (no. 6819), *Amsonia rigida* (no. 6820, distributed as *A. Tabernæmontana*), *Eleocharis Torreyana* (no. 6821, distributed as *E. microcarpa*),

[1] See Coult. & Rose, *Contr. U. S. Nat. Herb.* **7**: 49. 1901.

and *Oxytria crocea* (?) near Allapaha, and *Euphorbia eriogonoides* (no. 6822, distributed as *E. Curtisii*) and *E. corollata angustifolia* near Pearson.

In June, 1900, April and August, 1901, and April, 1902, Mr. C. L. Boynton of Biltmore, N. C., passed through the Altamaha Grit region, making collections in the vicinity of Rocky Ford, Eastman, McRae, Lumber City, Baxley, and Tifton. Few of his specimens from these places have been distributed to northern herbaria, and apparently the only one thus far[1] mentioned in print is *Marshallia ramosa*, which he discovered near Eastman in 1900.

Several botanists residing in Georgia have been in this region at various times, but none of them have published anything about it, and their specimens from that part of the state (if any) are not accessible to the public.

My own travels have taken me through every county in the Altamaha Grit region, in five different years, and in every month of the year except November, December, and January. The dates, counties visited, and numbers of specimens collected may be tabulated as follows.

1900.

Sept. 19. Dooly, Worth, Irwin, Berrien (658–669).
Sept. 20–28. Ware, Appling, Coffee (671–724).

1901.

June 4. Screven.
June 6–19. Emanuel (802–820), Bulloch (821–916), Screven.
June 24—July 4. Screven, Bulloch (939–974), Emanuel (975-984), Bulloch (984a–988), Emanuel (989–996), Tattnall (997–1002), Montgomery, Telfair.
July 4. Wilcox, Dooly.
August 8. Mitchell, Thomas.
August 9. Thomas (1172–1181).
August 11, 12. Decatur.
August 13, 14. Decatur.

1902.

June 25. Dodge.
June 28. Wilcox, Dooly.
July 14. Dooly, Wilcox.
July 15–Aug. 1. Irwin (1414–1422), Coffee (1423–1463), Appling, Ware.

[1] At least up to April, 1905.

Sept. 20–Oct. 4. Thomas, Colquitt (1640–1676a), Worth, Berrien (1677–1696a), Worth (1697, 1698), Berrien (1699–1701), Irwin (1702–1704), Berrien (1705–1707), Irwin (1708–1711), Wilcox, Dooly.

1903.

June 23–July 5. Tattnall (1851–1862), Montgomery (1863–1872), Telfair (1873), Dodge.

July 6–7. Wilcox, Dooly.

August 8. Decatur.

August 13. Decatur (1929).

August 14, 15. Decatur (1931, 1932).

August 18. Decatur.

August 18. Thomas, Mitchell.

August 20. Mitchell, Thomas (1938).

August 22–26. Thomas, Colquitt (1904–1948), Worth.

August 28, 29. Worth, Berrien, Irwin, Worth, Dooly (1955–1957).

Sept. 1. Dooly.

Sept 8–12. Dodge (1976a–1980), Telfair, Montgomery (1981–1986) Telfair, Montgomery (1987–1990), Telfair (1990a), Coffee (1991, 1992), Appling (1993, 1994), Wayne.

Sept. 20–23. Pierce, Appling, Coffee (2010–2014), Irwin, Wilcox, Dooly.

1904.

February 2–9. Dooly, Wilcox, Irwin, Coffee (2044–2050), Appling, Ware.

February 16. Decatur.

March 31, April 1. Screven, Bulloch (2079, 2080), Screven (2081–2083 +).

April 1–4. Screven (2089, 2090), Bulloch (2091), Screven.

April 4–6. Emanuel (2092–2098).

April 23–29. Laurens, Montgomery (2145, 2146), Tattnall (2147–2160), Bulloch (2161–2169).

May 5–7. Ware, Coffee, Berrien (2189–2191), Coffee (2192), Berrien (2193–2196).

May 9–18. Berrien (2197), Irwin, Coffee (2198–2205), Irwin, Wilcox, (2206–2209), Irwin (2210, 2211).

May 18, 19. Wilcox (2212), Dooly.

TAXONOMIC CLASSIFICATION OF THE FLORA.

In the following pages are arranged in systematic sequence the species which have already been classified according to habitat and adaptations, together with a few which do not appear in the foregoing habitat lists because their habitats are not sufficiently understood. The sequence is mainly that of Engler & Prantl's *Naturlichen Pflanzenfamilien*, but reversed, for it seems more expedient to begin with the flowering plants, which are best known, and to place the comparatively little known bryophytes and thallophytes last, ending with forms whose status in the vegetable kingdom is not universally accepted. In so doing I follow the usage of most systematists from Linnæus to Gray. This implies no discredit to the accepted theories of evolution, but is primarily a matter of convenience. There seems to be no logical reason why the top of the series is not just as good to begin with as the bottom. This is analogous to the practice of geologists, who always begin their stratigraphic sections at the top.

As far as the arrangement of genera and species within the families is concerned, I usually follow Small's *Flora of the Southeastern United States*, which is the latest systematic treatment of the plants of that region. In a few cases I have deviated from Dr. Small's arrangement in order to bring closely related genera or species nearer together. The treatment of genera and species herein is in most cases a little more conservative than that in Small's *Flora*.

Nomenclature is in a somewhat unsettled state at present, pending the adoption of the Philadelphia or the Vienna rules, and in trying to avoid the defects of the older systems and adopt the best features of the new I have doubtless allowed some inconsistencies to creep in, all of which cannot very well be eliminated until the nomenclature of the whole flora of the southeastern

states is revised according to one or the other of the new systems. But fortunately most of the plants of the Altamaha Grit region were not known to the systematists of the 18th century (as will be shown farther on), and their synonymy is not yet as involved as is that of the plants of most other parts of Eastern North America.

As the names of families form no part of the names of plants and are comparatively few, it does not seem necessary that they should be determined by strict rules. And as no two modern authors agree exactly as to the correct name for each family, I have used those family names which were best known a dozen years ago.

Pretty full synonymy for most of the species here enumerated can be found either in Watson's *Bibliographical Index*, MacMillan's *Metaspermæ of the Minnesota Valley*, the fifth volume of the *Memoirs of the Torrey Botanical Club*, or in Mohr's *Plant Life of Alabama*. Consequently in this catalogue synonyms are usually omitted except for such species as are not mentioned in any of these works, or have had a recent change of name. The use of parenthetical citations of authors, which has become common in the last fifteen years, largely obviates the necessity or giving synonyms in a work of this kind. A slight variation of the parenthetical citation is here introduced. Where a species has been transferred from one genus to another, or a variety from one species to another in the same genus, the name of the original author is put in parentheses, as usual. But where a variety has been raised to a species, or *vice versa*, brackets are used instead. There are a few cases where a combination of both is necessary (e. g., *Taxodium imbricarium*). This device will add somewhat to the definiteness of citations where synonyms are omitted.

The names of species believed not to be indigenous to the region are printed in small capitals. Other accepted names are in **full-face** type, and all synonyms (except those of genera) in italics. The place of publication of every genus and species is given, when known, and most of them I have verified personally. The abbreviations of authors' names and of the titles of their works are mostly those in common use, and will be understood by all systematists.

Common names are given in many cases, and divided into three classes. Those which I know to be used in the Altamaha Grit region are enclosed in quotation marks, those which seem not to be used there, but in other parts of Georgia, are in parentheses, and those which I am not sure about have no such marks. All common names are printed in small capitals, and each is placed immediately after the citation of the specific name, or after the generic name if it is applied indiscriminately to all the species of a genus.

The remarks under each species includes first its habitat or habitats, often with notes on its relative abundance, and then its known distribution within the region, usually by counties if it is not common throughout. When a species has not been observed in every county it is not always safe to assume that it grows in all of them, and for species which are known in only a few counties it may be possible hereafter to discover climatic or other barriers which prevent them from spreading in some directions. For this reason I have gone into what may seem unnecessary detail in discussing the distribution of all but the commonest species. The counties enumerated in each case are arranged as nearly as possible in geographical order from northeast to southwest, and the names of those within the region are printed in small capitals, the word county being usually omitted.[1]

The numbers in parentheses associated with the county names refer to my collection numbers,[2] and the date on which any particular number was collected can be found (approximately at

[1] In August, 1905, the Georgia legislature created eight new counties, seven of which include parts of the Altamaha Grit region. But as the field work on which this flora is based was of course all done (and the specimens labeled) before the change was made, and at this writing no accurate map of the new counties has yet been published, it is obviously impracticable to correlate my notes with the new state of affairs at present. Consequently the new counties are here ignored, and the distribution given in the following pages is based on the map which forms the frontispiece, which shows the political boundaries as they existed during my residence and subsequent explorations in Georgia.

[2] All the vascular plants I have collected in Georgia since the middle of June, 1900, have been numbered consecutively, and the numbers for bryophytes and thallophytes have been interpolated by the addition of the letters *a*, *b*, *c*, etc. Nearly complete sets of these plants, aggregating

least) in the chronological summary of my travels a few pages back, if desired.

Some authors of local floras have been particular to cite localities only for existing herbarium specimens. This of course is the safest rule to observe when one is writing up the flora of a region which he has not explored much himself, but in the present case it would be totally inadequate. Had I followed this rule I would have been restricted to about 550 specimens collected by myself and not over 50 collected by other persons, representing perhaps 500 species. As it is, I have usually tried while in the field to note each plant at least once in each county each season, and I have probably by this time ten stations for each species, on the average (over a hundred for some, though), making several thousand individual records in all, which is probably more than the total number of specimens from the whole state of Georgia represented in any one herbarium at present.

The records of local distribution in the following list are based solely on my own notes and collections. This eliminates any variation due to different personal equations, except where my own views may have changed unconsciously between seasons. Some species collected in this region by other botanists have been enumerated a few pages back, but to include them, and all other available specimens, would not have added one per cent. to the number of species in the list or the number of stations. Another reason for not including specimens collected by others is that most of them have the serious defect of not being accompanied by sufficient indication of habitat, which renders them almost worthless for my purposes; for throughout this work habitat is regarded as of the greatest importance. Furthermore, completeness is not essential in a preliminary sketch of this kind.

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now about 2500 numbers (representing perhaps 1700 species), can be found at the New York Botanical Garden, U. S. National Herbarium, Gray Herbarium of Harvard University, Missouri Botanical Garden, and Edinburgh Royal Botanic Garden. Partial sets are in the possession of the Field Columbian Museum, British Museum, University of Nebraska, and the Botanical Gardens at Kew, Berlin, Paris, and Vienna. Most of the trees and shrubs are represented in the herbarium of the Arnold Arboretum. From a dozen to a hundred or more specimens are in the collections of each of several smaller institutions and private individuals.

After the local distribution of each species is given its time of flowering, as far as known. In compiling these data I have made use of a long series of phænological notes, mostly from the vicinity of Macon and Washington, Ga., kindly furnished me by Miss E. F. Andrews (author of *Botany All the Year Round*), and of my own notes made in all parts of Georgia in the last ten years. Some correction has of course been made for difference of season in different latitudes, when collating notes of this kind from the northern half of the state. Plants in the Altamaha Grit region have just as definite flowering periods as those anywhere farther north, however the same species may behave in subtropical Florida and farther south, where there is not so much distinction between seasons.

The treatment of each species ends with a synopsis of its known geographical distribution, first with considerable detail as to its occurrence in other parts of Georgia, based on personal experience, and then its total known range, compiled from various manuals, monographs, and local floras. In discussing distribution within the state a distinction is often made between the upper third and the upper fourth of the coastal plain. By upper third is meant all north of the Altamaha Grit, and by upper fourth all north of the pine-barrens, or in other words only the Cretaceous and Eocene regions and fall-line sand-hills.

The total ranges I have attempted to correlate as far as possible with the physiographic divisions outlined near the beginning of this work, but the data for doing so are as yet much less complete than might be desired, for in most floras hitherto published ranges are given in terms of political divisions only. It should be borne in mind that the pine-barrens so frequently mentioned below always constitute only a part of the coastal plain (in Georgia about two-thirds), so that a species confined to the pine-barrens is in that respect always more restricted in range than one merely confined to the coastal plain.

The ranges here given have been compiled principally from Mohr's *Plant Life of Alabama* (which is about the only work of its kind in which natural divisions are made almost as prominent as political ones), and Small's *Flora of the Southeastern United*

States, the ranges in which are probably based on more copious material than those in Dr. Mohr's great work. Several other publications of more limited scope have been freely consulted, and their titles will be found in the bibliography. The ranges indicated in manuals and monographs are of course chiefly compiled from herbarium specimens, which are too often insufficiently labeled or otherwise unsatisfactory. More accurate results can be obtained by consulting a number of reliable local floras. This I have done in some cases, but it is too laborious a task to be followed consistently throughout. One of the greatest desiderata in systematic botany at present is the accurate determination of ranges,[1] and this catalogue it is hoped will be a slight contribution toward that end.

The advisability of mentioning ranges at all in a local flora may well be questioned by some. For no two authorities agree as to the ranges of many species, and any range even when apparently well known is liable to need revision by reason of errors in determination of some of the material, or changes in accepted specific limits, or more commonly for extensions of known range by discovery.[2] And if geographical variation of species was the rule, rather than the exception, it might be argued that no plants outside our territory should be considered absolutely indentical with those within. But fortunately most species do not vary perceptibly from one place to another, so range often becomes an important character of a species. So on the whole it seems best to attempt to give the known range of each as accurately as possible, in order to show the affinities of our flora with that of other parts of the country. As most if not all of the species have come into the region from elsewhere since Pleistocene times, it becomes a matter of considerable interest to study their origin, and some facts of this kind have already been brought out in the summaries of the foregoing habitat lists.

[1] See Robinson, *Science*, II. **14**: 472–473. 1901.

[2] Some botanists have even gone so far as to print ranges on herbarium labels, but this practice is scarcely to be recommended, for range is a property of the species and not of the individual, and if a specimen so labeled turns out to have been erroneously identified the range assigned to it loses its meaning.

No descriptions of the plants are attempted in this catalogue and no new combinations are published, though a few will probably be necessitated by the new rules of nomemclature. All the species mentioned, unless otherwise specified, are pretty fully described in Dr. Small's *Flora*, which should be in the hands of all who make any use of this paper. There is a good deal of information about each species scattered about through the foregoing pages, however, and to find it all the reader should consult the index.

Scattered through the catalogue at the proper places will be found references to morphological and anatomical studies by Kearney, W. E. Britton, Theo. Holm, and others, in which about fifty of our species are discussed. These will doubtless be of some service to any one who may hereafter have occasion to make a more thorough study of the flora of the same or a similar region.

References are also given to published illustrations of some of the rarer species, and little-known illustrations of some of the commoner ones, especially those which are not included in familiar illustrated works like Sargent's *Silva* and Britton & Brown's *Illustrated Flora*.

CATALOGUE OF SPECIES.

SPERMATOPHYTA.

CICHORIACEÆ.

KRIGIA Willd., Sp. Pl. **3**: 1618. 1804.

K. Virginica (L.) Willd., l. c.

Adopogon Carolinianus (Walt.) Britton, Mem. Torrey Club **5**: 346. 1894.

Dry pine-barrens and rock outcrops, or sometimes a roadside weed. SCREVEN (*2083*), BULLOCH, TATTNALL, and doubtless in most of the other counties. Fl. March–May.

Widely distributed in the Eastern United States, but natural range uncertain, on account of its marked tendency to become a weed.

LYGODESMIA D. Don, Edinb. New Phil. Jour. **6**: 311. 1829.

L. aphylla (Nutt.) DC., Prodr. **7**: 198. 1838.

Dry pine-barrens near the inland edge of our territory in IRWIN and WILCOX. Fl. May–July. More frequent in the lime-sink region.

Known only from the pine-barrens of Georgia and Florida.

HIERACIUM L., Sp Pl. 799. 1753.

There seem to be at least two representatives of this genus in our territory, both growing in dry pine-barrens. One has been noted in BULLOCH (*860*), where it flowers in June, and the other in IRWIN, BERRIEN, and COLQUITT, (*1653*), flowering in September and October. They seem to be near relatives of *H. Gronovii* L., but cannot very well be determined in the present state of our knowledge of the genus.

COMPOSITÆ (CARDUACEÆ).

CHAPTALIA Vent., Jard. Cels. *pl. 61*. 1800.

C. tomentosa Vent., l. c.

C. integrifolia (Mx.) Nutt., Gen. **2**: 182. 1818.

Thyrsanthema semiflosculare (Walt.) Kuntze, Rev. **1**: 369. 1891.

Moist pine-barrens, rather common throughout. Fl. Feb.–April. Evergreen.

North Carolina to Florida and Texas, in the pine-barrens.

CARDUUS L., Sp. Pl. 820. 1753. THISTLE.

C. spinosissimus Walt., Fl. Car. 194. 1788.

Dry pine-barrens along railroads near Fitzgerald, probably introduced. Fl. May. More common near the coast.

Widely distributed in the Eastern United States, mainly in the coastal plain, but native range uncertain.

C. revolutus Small, Fl. 1307. 1903.

Moist or intermediate pine-barrens. COFFEE, DOOLY, WORTH (*1697*), COLQUITT. Fl. Aug.–Sept. Occurs also in the Lower Oligocene region.

South Carolina to Florida, in the pine-barrens.

C. LeContei (T. & G.) Pollard, Bull. Torrey Club **24**: 157. 1897

Moist pine-barrens, COFFEE (*1425*). July, 1902.

Ranges westward to Louisiana in the pine-barrens.

SENECIO L., Sp. Pl. 866. 1753.

S. tomentosus Mx., Fl. **2**: 119. 1803.

On rock outcrop in TATTNALL, April 26, 1904, in flower.

Said to range from New Jersey to Florida, Arkansas, and Texas, but Dr. Mohr does not report it from Alabama, and its distribution is not well worked out. Elsewhere in Georgia I have seen it only on granite outcrops around Stone Mountain, and in dry pine-barrens near Omaha. In the vicinity of Dismal Swamp it is a common roadside weed, according to Kearney.

For a study of its leaf-anatomy see Kearney, Contr. U.S. Nat. Herb. 5; 509. 1901.

MESADENIA Raf.; Loud. Gard. Mag. **8**: 247. 1832.

M. Elliottii Harper, Torreya **5**: 184. 1905.

"*Cacalia ovata* Walt."; Ell. Sk. **2**: 310. 1822.

Seen only in damp woods, where the Lafayette formation is supposed to be absent (see page 111), in the northwestern corner of BERRIEN (*1701*). Fl. Aug.-Sept. Grows also farther inland, apparently under similar geological conditions, in Houston, Early, and perhaps other counties.

Ranges westward to Louisiana in the coastal plain.

M. lanceolata virescens Harper, Torreya 5:185. 1905.

Rather common in moist pine-barrens. DODGE, TELFAIR, APPLING, COFFEE, WILCOX, IRWIN, BERRIEN (*664*, *1678* type), DOOLY, WORTH, COLQUITT, THOMAS. Fl. Sept.-Oct.

Apparently confined to the region.

ERECHTHITES Raf., Fl. Lud. 65. 1817.

E. HIERACIFOLIA (L.) Raf.; DC. Prodr. **6**:294. 1837.

Low grounds near Moultrie, Aug. 22, 1903, evidently introduced.

Widely distributed in Eastern North America, but natural range and habitat unknown. Also in the Bahamas (*Northrop*).

ARNICA L., Sp. Pl. 884. 1753.

A. acaulis (Walt.) B. S. P., Prel. Cat. N. Y. 30. 1888[1]; Porter & Britton, Mem. Torrey Club **5**:342. 1894.

Intermediate pine-barrens, rare. BULLOCH, LAURENS. Fl. April-June.

Ranges from southeastern Pennsylvania to Florida, mostly in the coastal plain. In Georgia extends inland to Richmond and Johnson Counties and coastward to Effingham.

ACHILLEA L., Sp. Pl. 898. 1753. YARROW.

A. MILLEFOLIUM L., Sp. Pl. 899. 1753.

A weed along roadsides, mostly near dwellings. BULLOCH, TATTNALL, MONTGOMERY, BERRIEN. Fl. May-Oct.

Widely distributed in the Northern Hemisphere, but probably not native in the United States.

ANTHEMIS L., Sp. Pl. 893. 1753.

A. COTULA L., Sp. Pl. 894. 1753. DOG-FENNEL.

In similar situations to the preceding. SCREVEN, WILCOX, BERRIEN, and probably elsewhere. Fl. May-Aug.

Native of Europe, abundantly naturalized in the United States.

[1] As complete synonymy for new combinations is not given in the *Preliminary Catalogue of Anthophyta and Pteridophyta*, I have added in this and the seven or eight similar cases in this flora, a reference to the first subsequent publication in which the omission is supplied.

GAILLARDIA Foug., Mem. Acad. Sci. Par. **1786**: 5. *pl. 1, 2.* 1786.

G. lanceolata Mx., Fl. **2**: 142. 1803.

Dry pine-barrens, sand-hills, etc.; not common. TATTNALL, MONTGOMERY, COLQUITT. Fl. June–Sept.

South Carolina to Florida and Texas in the coastal plain, also inland to Kansas.

LEPTOPODA Nutt., Gen. **2**: 174. 1818.

L. Helenium Nutt., l.c.

L. *decurrens* Macbride; Ell., Sk. **2**: 446. 1823.

Moist pine-barrens and shallow ponds. SCREVEN, BULLOCH (*2167*), EMANUEL, TATTNALL, MONTGOMERY, COFFEE, WILCOX, IRWIN, BERRIEN, and perhaps in all the other counties. Fl. April–May.

South Carolina to Florida and Louisiana, in the pine-barrens.

HELENIUM L., Sp. Pl. 886. 1753.

H. nudiflorum Nutt., Trans. Am. Phil. Soc. II. **7**: 384. 1841.

Leptopoda brachypoda T. & G., Fl. **2**: 388. 1842.

Low grounds near the Canoochee and Ohoopee Rivers and Pendleton Creek in TATTNALL, June, 1903, in flower. Grows also near the sources of the Ohoopee River, a little outside of our limits.

Virginia to Florida, Missouri, and Texas, in the coastal plain.

H. autumnale L., Sp. Pl. 886. 1753.

In low grounds, particularly where the Lafayette formation seems to be absent. DOOLY, IRWIN, BERRIEN, COFFEE (*714*). Fl. Aug.–Oct.

Widely distributed east of the Rocky Mountains, but perhaps not everywhere native.

H. TENUIFOLIUM Nutt., Jour. Acad. Phila. **7**: 66. 1834. BITTER WEED.

Our commonest weed, along roads and railroads throughout. Fl. May–Nov.

Now widely distributed in the southeastern states, but probably native only in the Mississippi valley or farther west. It has spread rapidly in Georgia in the last 15 or 20 years (see Bull. Torrey Club, **28**: 484. 1901), but it is still rather scarce in the flat pine-barrens toward the coast.

HYMENOPAPPUS L'Her.; Mx., Fl. **2**:103. 1803.

H. Carolinensis (Lam.) Porter, Mem. Torrey Club, **5**:338. 1894.

Dry sandy soil, BULLOCH and MONTGOMERY; perhaps not native. May–June. Common around Millen, just north of our limits.

Said to range from South Carolina to Florida, Kansas, and Texas, just as in the case of *Gaillardia lanceolata*, which it also resembles in habitat. Not reported from Alabama.

MARSHALLIA Schreb.; Gmel. Syst. **2**:1208. 1791. (Not of page 836 of same work.)

PHYTEUMOPSIS Juss;. Poir., Suppl. **4**:405. 1816.

M. ramosa Beadle & F. E. Boynton, Biltmore Bot. Stud. **1**:8. *pl. 2.* 1901.

Dry rock outcrops, TATTNALL (*1855*) and DODGE. Fl. June. Occurs also in Johnson County, near the inland edge of our territory.

Endemic or nearly so. (See Bull. Torrey Club, **32**:170. 1905; Torreya, **5**:114. 1905.)

M. graminifolia (Walt.) Small, Bull. Torrey Club, **25**:482. 1898.

Moist pine-barrens, not rare. COFFEE, IRWIN (*1416*), BERRIEN, COLQUITT, THOMAS (*1180*). Fl. July–Sept. Not known farther inland, but extends well down into the flat pine-barren region.

North Carolina to northern Florida and Louisiana, in the pine-barrens.

ACTINOSPERMUM Ell., Sk. **2**:448. 1823.

A. angustifolium (Pursh) T. & G., Fl. **2**:389. 1842.

Baldwinia multiflora Nutt., Gen. **2**:176. 1818.

Sand-hills and sand-hammocks; frequent from BULLOCH to COFFEE (*697*) and the northeastern corner of BERRIEN. Fl. September. Inland to Laurens County (opposite Dublin), and along the Canoochee, Altamaha, Satilla, and Little Satilla Rivers well down into the flat country.

Also known from several stations in Florida, and on the coast of Alabama.

BALDWINIA Nutt., Gen. **2**: 175. 1818.

B. uniflora Nutt., l. c.

Dry, intermediate, and moist pine-barrens; common not only in our territory but throughout the pine-barrens of Georgia, *i. e.*, from the inland edge of the Lower Oligocene to within a few miles of the coast. Fl. July–September.

North Carolina to northern Florida and Louisiana, strictly confined to the coastal plain.

B. atropurpurea Harper, Bull. Torrey Club **28**: 483. 1901.

Moist pine-barrens, not rare. BULLOCH, COFFEE, WILCOX, IRWIN, BERRIEN (*662*, type), DOOLY, WORTH, COLQUITT (*1644*). Fl. Aug.–Oct. Also in Wayne and Pierce Counties, in the flat pine-barren region. (See Bull. Torrey Club **31**: 26. 1904; **32**: 270. 1905; Torreya **5**: 114. 1905.)

Not known elsewhere.

BIDENS L., Sp. Pl. 832. 1753.

B. BIPINNATA L., l. c. SPANISH NEEDLES.

A weed. Seen in the streets of Tifton, Sept. 27, 1902. More common in the older-settled parts of the state.

Widely distributed in the Eastern United States and Mexico, but natural range and habitat uncertain.

COREOPSIS L., Sp. Pl. 907. 1753.

C. nudata Nutt., Gen. **2**: 180. 1818.

Common in shallow ponds, and occasionally in branches. BULLOCH, TATTNALL (*1001*), COFFEE (*2198*), IRWIN, BERRIEN, COLQUITT. Fl. April–June. Widely distributed in the pine-barrens of Georgia.

Also reported from northeastern Florida.

C. angustifolia Ait., Hort. Kew. **3**: 253. 1789.

Moist pine-barrens. COFFEE, WILCOX, IRWIN, BERRIEN (*661*), DOOLY, COLQUITT (*1666*), THOMAS. Fl. July–Sept.

North Carolina to Florida and Louisiana, in the pine-barrens.

Several species very closely related to this have been proposed, and some of my material may perhaps be referable to one or more of them.

C. delphinifolia Lam., Encyc. **2**: 108. 1786.

(?) *C. Wrayi* Nutt., Jour. Acad. Phil. **7**: 76. 1834.

Chiefly in dry pine-barrens. TATTNALL, MONTGOMERY, TELFAIR, WILCOX, DOOLY. Fl. June–Aug. Extends inland to Sumter County and coastward to Effingham.

Virginia (?) to Alabama (?). Range imperfectly understood.

C. lanceolata L., Sp. Pl. 908. 1753.

Dry pine-barrens and sand-hills. BULLOCH (*2169*), TATTNALL, MONTGOMERY, BERRIEN. Fl. April–June.

Has a wide distribution in the Eastern United States, which has not been carefully worked out. In Georgia known only from the coastal plain.

VERBESINA L., Sp. Pl. 901. 1753.

V. Virginica L., l. c.

Wooded bluffs along the Oconee and Ocmulgee Rivers near Mount Vernon and Lumber City. Fl. September. More common in the upper third of the coastal plain, and in Middle Georgia.

Pennsylvania to central Florida, Missouri, and Texas, in the Piedmont region and coastal plain.

HELIANTHUS L., Sp. Pl. 904. 1753.

H. australis Small, Fl. 1268. 1903.

MONTGOMERY: Dry woods along Oconee River near Mount Vernon, June 29, 1903 (1864).

Said to range south to Florida and west to Louisiana.

H. Radula (Pursh) T. & G., Fl. **2**:321. 1841.

Normally in intermediate pine-barrens ; common throughout our territory and the rest of the pine-barrens of Georgia. Fl. Sept.–Oct.

Georgia and Florida to Louisiana (?), in the pine-barrens.

H. angustifolius L., Sp. Pl. 906. 1753.

Moist pine-barrens. IRWIN, COLQUITT. Fl. Sept.–Oct. Known also from a few stations in the upper third of the coastal plain and in Middle Georgia.

New Jersey to Florida, Missouri, and Texas, mostly in the coastal plain.

H. undulatus Chapm., Fl. ed. 3, 253. 1897.

Moist pine-barrens, especially along the edges of branch-

swamps. TELFAIR, COFFEE (*671*), IRWIN, BERRIEN, WORTH, COLQUITT. Fl. Sept.–Oct.

Pine-barrens of Georgia, Florida, and Alabama.

RUDBECKIA L., Sp. Pl. 906. 1753.

R. hirta L., Sp. Pl. 907. 1753.

Usually in dry pine-barrens. BULLOCH (*823, 870*), TATTNALL, MONTGOMERY, COLQUITT, MITCHELL, DECATUR. Fl. May–Sept.

Widely distributed in the Eastern United States, but only as an introduced plant northeastward, so that its natural range is uncertain.

R. foliosa C. L. Boynton & Beadle; Small, Fl. 1256. 1903.

BERRIEN: Low grounds southwest of Tifton, where the Lafayette formation is presumably absent (*1692*); DOOLY: Around a lime-sink east of Wenona, just at the edge of our territory (*1962*). Fl. July–Sept.

North Carolina to Florida.

R. nitida Nutt., Jour. Acad. Phila. **7**: 78. 1834.

Mostly in intermediate pine-barrens. BULLOCH, TATTNALL, MONTGOMERY, DODGE. Fl. June, July. Not observed west of the Ocmulgee River. Extends inland to Johnson and Laurens Counties, perhaps little if at all beyond our limits.

Said to range westward to Texas, but not reported from Alabama.

R. Mohrii Gray, Proc. Am. Acad. **17**: 217. 1882. (See Bull. Torrey Club **27**: 435. 1900.)

Usually in and around shallow ponds, more rarely in moist pine-barrens. APPLING, DODGE, DOOLY, IRWIN, BERRIEN, WORTH, COLQUITT. Fl. June–Sept. Extends inland to Pulaski, Sumter, Calhoun, and Early Counties in the Lower Oligocene region, and coastward to Ware and Lowndes in the flat country.

Otherwise known only from Middle and West Florida.

TETRAGONOTHECA L., Sp. Pl. 903. 1753.

T. helianthoides L., l. c.

Dry pine-barrens in the northern part of COFFEE County, be-

tween Pridgen and Barrow's Bluff, May 14, 1904, in flower. Doubtless elsewhere in our territory, but nowhere common, and not free from the suspicion of being introduced in some places.

Virginia to Florida and Mississippi, in the Piedmont region and coastal plain.

BERLANDIERA DC., Prodr. **5**: 517. 1836.

B. pumila (Mx.) Nutt., Trans. Am. Phil. Soc. II. **7**: 342. 1840.
B. tomentosa (Pursh) Nutt., l.c. 343.

Dry pine-barrens, sand-hills, etc.; not abundant. TATTNALL, MONTGOMERY, TELFAIR, COFFEE, DECATUR. Fl. April–Sept. Pretty widely distributed over South Georgia.

North Carolina to Florida and Arkansas, in the coastal plain.

SILPHIUM L., Sp. Pl. 919. 1753.

S. Asteriscus angustatum Gray, Syn. Fl. ed. 2, **1**^{2}: 449. 1886.
S. angustum Small, Fl. 1244. 1903.
(?) *S. lanceolatum* Nutt., Trans. Am. Phil. Soc. II. **7**: 341. 1840.

COLQUITT: Dry pine-barrens south of Moultrie, Aug. 24, 1903 (*1947*).

Nuttall's plant, which may be the same as ours, came from the vicinity of Milledgeville.

Known otherwise from Gadsden County, Florida, and Baldwin and Mobile Counties, Alabama.

S. compositum Mx., Fl. 2: 145. 1803.

TELFAIR: Dry pine-barrens southwest of McRae, July 4, 1903.

North Carolina to northern Florida and Alabama, from the mountains to the coastal plain.

ACANTHOSPERMUM Schrank, Pl. Rar. Hort. Monac. **2**: *pl. 53*. 1819.

A. AUSTRALE (L.) Kuntze, Rev. **1**: 303. 1891.

One of our commonest weeds, growing along roads and railroads in nearly every settlement, usually with *Helenium tenuifolium*. Fl. May–Oct.

Introduced from the tropics, and now common from North Carolina to Florida and Louisiana, especially in the coastal plain.

GNAPHALIUM L., Sp. Pl. 850. 1753.

G. PURPUREUM L., Sp. Pl. 854. 1753.

A weed of fields and roadsides, noted in May, 1904, near Fitzgerald and Nashville. More common in other parts of the state.

Widely distributed in North America, but natural range and habitat unknown.

G. OBTUSIFOLIUM L., Sp. Pl. 851. 1753. RABBIT TOBACCO.

Seen from train in Ashburn, WORTH Co., Aug. 29, 1903. Very common in the northern half of the state.

Range similar to that of the preceding.

PTEROCAULON Ell., Sk. **2**:323. 1823.

CHLÆNOBOLUS Cass., Dict. Sci. Nat. **49**:337. 1827.

CHÆNOLOBUS Small, Fl. 1235. 1903.

P. undulatum (Walt.) Mohr, Contr. U. S. Nat. Herb. **6**:790. 1901. "BLACK ROOT."

P. pycnostachyum (Mx.) Ell., Sk. **2**:324. 1823.

Chænolobus undulatus Small, Fl. 1236. 1903.

Normally in intermediate pine-barrens; nearly throughout our territory and in all the pine-barrens of Georgia, especially coastward. Fl. May–June.

North Carolina to Florida and Alabama, in the pine-barrens.

PLUCHEA Cass., Bull. Soc. Philom. **1817**: 31. 1817.

LEPTOGYNE Ell., Sk. **2**:322. 1823.

P. petiolata Cass., Dict. Sci. Nat. **42**:2. 1826.

TELFAIR: Ocmulgee River swamp near Lumber City, Sept. 11, 1903. More frequent farther inland.

Widely distributed in the Eastern United States south of latitude 38°.

P. imbricata [Kearney] Nash, Bull. Torrey Club **23**:108. 1896.

Branch- and creek-swamps and shallow ponds. TATTNALL, MONTGOMERY, APPLING, COFFEE (*1430*), COLQUITT, Fl. June–Sept. Not observed farther inland, but grows in the flat country around Okefinokee Swamp. Easily distinguished from the next.

Otherwise known only from eastern Florida.

P. bifrons (L.) DC., Prodr. **5** : 451. 1836.

In shallow ponds, especially cypress ponds. TATTNALL, COFFEE, IRWIN, COLQUITT. Fl. June–Sept. Also farther inland and nearer the coast, but confined to the pine-barrens. Rarely if ever associated with the preceding.

New Jersey to South Florida and Texas, in the coastal plain. Also in the Bahamas (*Northrop*).

Leaf-anatomy described by Kearney, Contr. U. S. Nat. Herb. **5**: 508. 1901.

BACCHARIS L., Sp. Pl. 860. 1753.

B. halimifolia L., l. c.

Principally in creek- and river-swamps, but also around extinct sawmills and in some other places where it cannot possibly be native. BULLOCH, EMANUEL, MONTGOMERY, BERRIEN. Flowers very late if at all in our territory.

Massachusetts to Florida and Texas, chiefly along the coast. For discussion of its leaf-anatomy see Kearney, Contr. U. S. Nat. Herb. **5**: 307,308. 1900; 508,509. 1901.

IONACTIS Greene, Pittonia **3**: 245. 1897.

I. linariifolia (L.) Greene, l. c.

MONTGOMERY: Dry pine-barrens near Mount Vernon, June 30, 1903. Flowers late. Occurs sparingly in all parts of Georgia.

Widely distributed in the Eastern United States.

Leaf-anatomy discussed by W. E. B itton, Bull Torrey Club **30**: 597. *pl. 260*. 1903.

DŒLLINGERIA Nees, Gen. & Sp. Ast. 176. 1832.

D. reticulata (Pursh) Greene, Pittonia **3**: 53. 1896.

Diplopappus obovatus (Nutt.) T. & G., Fl. **2**: 184. 1841.

Intermediate pine-barrens, etc.; nearly throughout our territory and coastward, but not known farther inland.

South Carolina to central Florida, in the pine-barrens.

LEPTILON Raf., Am. Month. Mag. **2** : 268. 1818.

L. CANADENSE (L.) Britton, Ill. Fl. **3**: 391. *f. 3827*. 1898.

A roadside weed. TATTNALL: Collins; COLQUITT: Moultrie. Common farther inland.

Widely distributed in North and South America, Europe and Asia, but natural range and habitat unknown.

ERIGERON L., Sp. Pl. 863. 1753.

E. ramosus (Walt.) B. S. P., Prel. Cat. N. Y. 27. 1888; MacM., Met. Minn. 526. 1892.

MONTGOMERY: Dry sandy soil near Mount Vernon, June 30, 1903. Probably not native.

Widely distributed in North America, doubtless a weed in most places.

E. vernus (L.) T. & G., Fl. **2**: 176. 1841.

Intermediate and moist pine-barrens and shallow ponds, nearly throughout the pine-barrens of Georgia. Fl. April–August.

Virginia to South Florida and Louisiana, in the coastal plain.

ASTER L., Sp. Pl. 872. 1753.

A. eryngiifolius T. & G., Fl. **2**: 502. 1843.

DECATUR: Moist pine-barrens near Recovery, Aug. 14, 1903. (*1932.*) Rare. Fl. summer.

Known otherwise only from adjacent parts of Florida. (See Bull. Torrey Club **32**: 169. 1905.)

A. squarrosus Walt., Fl. Car. 209. 1788. (Not of All., 1785.)

Intermediate pine-barrens, etc. SCREVEN, EMANUEL, TATTNALL, APPLING, COFFEE (*710*), IRWIN, BERRIEN (*658*), COLQUITT. Frequent in our territory and coastward. Flowers probably in November. Extends inland a little beyond our limits, in Johnson, Laurens, and Dooly Counties.

North Carolina to northeastern Florida, in the pine-barrens.

A. adnatus Nutt., Jour. Acad. Phila. **7**: 82. 1834.

Intermediate pine-barrens; less common than the preceding. BERRIEN, COLQUITT, THOMAS. Also in Sumter, Lee, Mitchell, and Early Counties in the Lower Oligocene region. Flowers probably in November.

Pine-barrens of Georgia, Florida, and Alabama. Also in the Bahamas (*Britton*).

SERICOCARPUS Nees, Gen. & Sp. Ast. 148. 1832.

S. bifoliatus (Walt.) Porter, Mem. Torrey Club **5**: 322. 1894.

S. tortifolius (Mx.) Nees, Gen. & Sp. Ast. 151. 1832.

Aster Collinsii Nutt.

Usually on sand-hills, sometimes in dry pine-barrens. BULLOCH, MONTGOMERY, APPLING, IRWIN, COLQUITT, THOMAS, DECATUR. Fl. Aug.–Sept.

Virginia to Florida and Louisiana, in the coastal plain.

BOLTONIA L'Her., Sert. Angl. 27. 1788.

B. diffusa Ell., Sk. **2**:400. 1823.

DODGE: Low grounds southeast of Eastman; BERRIEN: Moist pine-barrens southwest of Tifton, where the Lafayette formation is presumably absent (See p. 112). Fl. September. More common in the Lower Oligocene region.

South Carolina to Florida, Illinois, and Texas, in the coastal plain.

SOLIDAGO L., Sp. Pl. 878. 1753. GOLDEN-ROD.

S. Boottii Hook., Comp. Bot. Mag. **1**:97. 1835.

On sand-hills, near the hammocks at their bases. MONTGOMERY (*1983*), COFFEE. Fl. September. Also noted along the Flint River in Sumter County and the Altamaha in Liberty.

Virginia to northeastern Florida and Texas, in the coastal plain.

S. brachyphylla Chapm.; T. & G., Fl. **2**:218. 1842.

COFFEE: Woods at edge of Ocmulgee River swamp opposite Lumber City, Sept. 11, 1903. DOOLY: Edge of lime-sink east of Wenona (*1960*). Fl. Aug.–Oct. Also noted in Sumter and Clarke Counties, farther inland.

Middle Georgia to Florida and Mississippi.

S. odora Ait., Hort. Kew. **3**:214. 1789.

Sand-hills and dry pine-barrens. MONTGOMERY, COFFEE (*699*), IRWIN, BERRIEN, COLQUITT. Fl. Sept.–Oct. Extends inland to the mountains.

New England to Mexico.

EUTHAMIA Nutt., Gen. **2**:162. 1818.

E. Caroliniana (L.) Greene; Porter & Britton, Mem. Torrey Club **5**:321. 1894.

Solidago tenuifolia Pursh, Fl. 540. 1814.

Usually a weed, in dry or slightly damp uncultivated soil. COFFEE, WILCOX, BERRIEN, COLQUITT. Fl. Sept.–Oct.

Massachusetts to Florida and Texas, mostly in the coastal plain, but natural range and habitat uncertain.

CHRYSOMA Nutt., Jour. Acad. Phila. **7**: 67. 1834.

C. paucifiosculosa (Mx.) Greene, Erythea **3**: 8. 1895.

MONTGOMERY: Sand-hills of Gum Swamp Creek (*1986*) and Little Ocmulgee River, Sept. 10, 1903; not quite in flower. (See Bull. Torrey Club **32**: 168,169. 1905.)

South Carolina to Florida and Mississippi, mostly along the coast. Anatomy discussed by Lloyd, Bull. Torrey Club **28**: 445–450. *f. 1–5.* 1901.

ISOPAPPUS T. & G., Fl. **2**: 239. 1842.

I. DIVARICATUS (Nutt.) T. & G., l. c.

A weed in dry sandy soil. DODGE, TELFAIR, IRWIN. Fl. July–Sept. First discovered near Savannah by Dr. Baldwin, and ranges inland at least to the vicinity of Atlanta.

South Carolina to northern Florida, Texas, and Kansas; a range much like that of *Hymenopappus* and *Gaillardia*. Perhaps native westward, but certainly not in Georgia.

CHONDROPHORA Raf., New Fl. N. A. **4**: 79. 1836.

C. nudata (Mx.) Britton, Mem. Torrey Club **5**: 317. 1894.

Intermediate and moist pine-barrens, throughout our territory and neighboring pine-barren regions, often very abundant. Fl. Aug.–Sept.

New Jersey to Florida and Texas (?), in the pine-barrens.

C. virgata (Nutt.) Greene, Erythea **3**: 91. 1895.

Rock outcrops. TATTNALL (*1857*), DOOLY (*1955*). Fl. September.

Otherwise definitely known only from Carboniferous rocks in the mountains of Alabama. (See Bull. Torrey Club **32**: 168. 1905.)

CHRYSOPSIS Nutt., Gen. **2**: 150. 1818.

C. gossypina (Mx.) Nutt., l. c.

Sand-hills and dry pine-barrens. IRWIN, BERRIEN, COLQUITT. Fl. Sept.–Oct. Scattered over the pine-barrens of Georgia in similar situations.

Virginia (?) to Florida and Louisiana (?), in the coastal plain.

C. graminifolia (Mx.) Nutt., Gen. 2:151. 1818.

Dry pine-barrens, sand-hills, etc.; frequent but not abundant. Fl. Aug.–Nov. Ranges nearly all over Georgia in dry sandy soil, like *Ionactis* and *Solidago odora.*

Maryland to South Florida and Texas. Also in the Bahamas (*Britton*).

CARPHEPHORUS Cass., Bull. Soc. Philom. **1816:** 198. 1816.

C. tomentosus (Mx.) T. & G., Fl. **2**:66. 1841.

Rather dry flat pine-barrens, not abundant. APPLING (*1993*), PIERCE. Fl. September. Also in Wayne Co. in the flat country, but never seen farther inland.

North Carolina to Florida (?), in the pine-barrens.

C. Pseudo-Liatris Cass., l. c.

Liatris squamosa Nutt., Jour. Acad. Phila. **7**:73. 1834.

COLQUITT: Seen two or three times in moist pine-barrens near Moultrie, September, 1902 (*1668*). Fl. Sept.–Oct. Not known elsewhere in Georgia.

South to West Florida, west to Louisiana (?), in the pine-barrens.

This species furnishes an interesting example of reduction of transpiration by means of reduced scale-like cauline leaves, which are rather rigid and closely set. Other characteristic inhabitants of the pine-barrens of Georgia (not all of them occurring in the Altamaha Grit region however) having a somewhat similar habit are the three *Asters* mentioned above, *Carphephorus corymbosus* (Nutt.) T. &. G., *Trilisa paniculata* (Walt.) Cass., *Tubiflora Carolinensis* (Walt.) Gmel., and *Hypericum pilosum* Walt.

LACINIARIA Hill, Veg. Syst. **4**:49. *pl. 46.* 1762.

L. elegans (Walt.) Kuntze, Rev. **1**:349. 1891.

Chiefly on sand-hills; not abundant. COFFEE, IRWIN, BERRIEN, COLQUITT. Fl. Aug.–Oct. Also in the upper third of the coastal plain.

Virginia to northern Florida, Missouri, and Texas, in the coastal plain.

L. squarrosa (L.) Hill, l. c.

COFFEE: Dry pine-barrens east of Douglas, July 19, 1902, in

flower. Also seen once in Sumter County and once on the mountains of Northwest Georgia.

Widely distributed in the Eastern United States.

L. gracilis (Pursh) Kuntze, l. c.

Rather dry-pine-barrens. BERRIEN (*1683*), WORTH. Also in Thomas County, a little south of our limits. Fl. Oct.

South to central Florida, west to Louisiana (?).

L. graminifolia (Walt.) Kuntze, l. c.

Dry pine-barrens. IRWIN, BERRIEN, COLQUITT. Fl. Sept.–Oct.

Virginia to Florida and Alabama, in the Piedmont region and coastal plain.

L. spicata (L.) Kuntze, l. c.

Moist pine-barrens. DODGE, COFFEE, WILCOX, IRWIN, BERRIEN, DOOLY, COLQUITT (*1652*). Fl. Aug.–Oct. Also in Sumter County.

Widely distributed in the Eastern United States, but in the South apparently confined to the coastal plain.

L. tenuifolia (Nutt.) Kuntze, l. c.

Sand-hills and dry pine-barrens. MONTGOMERY, DODGE, COFFEE, IRWIN, BERRIEN, COLQUITT. Fl. Aug.–Oct. Inland to the fall-line sand-bills.

North Carolina to Florida, in the coastal plain.

TRILISA Cass., Bull. Soc. Philom. **1818**: 140. 1818.

T. odoratissima (Walt.) Cass., l. c. "DEER-TONGUE."

Usually in intermediate pine-barrens, throughout the pine-barren region of Georgia. Fl. Aug.–Sept.

Virginia to central Florida and Louisiana, in the pine-barrens. For some interesting notes on this species, and a colored plate, see Meehan's Monthly **8**: 177–178. *pl. 12.* 1898.

T. paniculata (Walt.) Cass., l. c.

In similar situations to the preceding, and having about the same distribution in Georgia, but rather less common. Fl. Aug.–Sept.

Virginia to northern Florida, in the pine-barrens.

MIKANIA Willd., Sp. Pl. **3**: 1742. 1804.

WILLUGBÆYA Neck., Elem. **1**: 82. 1790. (Not *Willughbeja*

Scop.; Schreb., Gen. Pl. 162. 1789.) (See Fernald, Bot. Gaz. **31**: 189. 1901.)

WILLOUGHBYA Kuntze, Rev. **1**: 371. 1891.

WILLOUGHBÆYA Porter & Britton, Mem. Torrey Club **5**: 313. 1894.

WILLUGHBÆA Britton & Brown, Ill. Fl. **3**: 313. 1898.

M. scandens (L.) Willd., Sp. Pl. **3**: 1743. 1804.

Swamps of streams originating north of our territory. (See classification of streams on pp. 27, 28.) DODGE: Gum Swamp Creek near Eastman. COFFEE: Along Ocmulgee River opposite Lumber City Fl. July–Oct. Scattered over the state from Clarke County to Camden.

Massachusetts to Indiana, Florida, and Texas. Also in the Bahamas (*Northrop*).

CONOCLINIUM DC., Prodr. **5**: 135. 1836.

C. cœlestinum (L.) DC., l. c.

TELFAIR: Ocmulgee River swamp near Lumber City, Sept. 11, 1903. More common farther inland.

New Jersey to Missouri, South Florida, and Texas.

EUPATORIUM L., Sp. Pl. 836. 1753.

E. compositifolium Walt., Fl. Car. 199. 1788. "DOG FENNEL."

Common in dry pine-barrens, etc., throughout, but only along roads or paths or in other places which have been tampered with in some way, so that its status as a native is doubtful. Fl. October. Extends from Clarke County (see Bull. Torrey Club **27**: 341. 1900) to the coast.

North Carolina to northern Florida and Texas.

E. serotinum Mx., Fl. **2**: 100. 1803.

COFFEE: Ocmulgee River swamp opposite Lumber City, Sept. 11, 1903. Extends inland to Whitfield County and coastward to Camden, but not common in Georgia.

Maryland to Iowa, South Florida, and Mexico.

E. semiserratum DC., Prodr. **5**: 177. 1836.

TELFAIR: Ocmulgee River swamp near Lumber City, Sept. 11, 1903. Also in Charlton and Thomas Counties.

Virginia to Florida, Missouri, and Texas, in the coastal plain.

E. tortifolium Chapm., Bot. Gaz. **3**: 5. 1878.

COLQUITT: Dry pine-barrens south of Moultrie (*1946*). Fl. Aug.–Sept. Also reported from the fall-line sand-hills in Richmond County (*A. Cuthbert*), and from the pine-barrens of Decatur County (type-locality, *Chapman*) and neighboring parts of Alabama and Florida.

? E. **Mohrii** Greene; Mohr, Contr. U. S. Nat. Herb. **6**: 762. *pl. 11.* 1901.

APPLING: Flat pine-barrens near Prentiss (*1994*); BERRIEN: Margin of shallow pond near Tifton (*1681*).

E. lecheæfolium Greene, Pittonia **3**: 177. 1897.

DOOLY: Dry pine-barrens east of Wenona, Sept. 1, 1903. Also known from the lime-sink region of Decatur County, and neighboring parts of Florida and Alabama.

E. album L., Mant. 111. 1767.

Dry pine-barrens and sand-hills. COFFEE, WILCOX, BERRIEN, COLQUITT, DECATUR. Fl. July–Sept. Ranges inland to the mountains of Northwest Georgia.

Widely distributed in the Southeastern United States.

E. rotundifolium L., Sp. Pl. 837. 1753.

Intermediate and moist pine-barrens, etc., nearly throughout South Georgia. Fl. July–Sept. Occurs rarely in Northwest Georgia.

Widely distributed in the Southeastern United States, and extending northward to Long Island, mostly in the coastal plain.

E. verbenæfolium Mx., Fl. **2**: 98. 1803.

With the preceding or in similar situations, but less common. DODGE, TELFAIR, APPLING, IRWIN, COLQUITT. Fl. Aug.–Sept. Also in the flat country toward the coast, and in Pike County, Middle Georgia.

Range similar to that of *E. rotundifolium*, but extending northeastward to Massachusetts. (See Rhodora **7**: 76. 1905.)

E. perfoliatum L., Sp. Pl. 838. 1753. BONESET.

Branch-swamps, and places where the Lafayette formation is supposed to be absent; not common. BERRIEN, COLQUITT. Fl. September.

Widely distributed in the Eastern United States.

SCLEROLEPIS Cass., Bull. Soc. Philom. **1816:** 198. 1816.

S. uniflora (Walt.) B. S. P., Prel. Cat. N. Y. 25. 1888; Porter, Mem. Torrey Club **5:** 311. 1894.

Cypress and other ponds, mostly near the inland edge of the region. WILCOX, COLQUITT, DECATUR. Fl. May–July. Commoner in the Lower Oligocene region.

New Jersey to Florida and Alabama, in the coastal plain.

STOKESIA L'Her., Sert. Angl. 27, pl. 38. 1788.

S. lævis (Hill) Greene, Erythea **1:** 3. 1893. (Figured in Meehan's Native Flowers and Ferns, **2:** 49–52. *pl. 13*, 1879.)

DODGE: Moist pine-barrens near Suomi, Sept. 9, 1903 (*1980*); past flowering. Not known elsewhere in Georgia.

South Carolina to Louisiana, in the pine-barrens.

ELEPHANTOPUS L., Sp. Pl. 814. 1753.

E. nudatus Grac, Proc. Am. Acad. **15:** 47. 1880.

TELFAIR: Rather dry pine-barrens near Lumber City, Sept. 11, 1903. BERRIEN: Low woods southwest of Tifton, Sept. 29, 1902. (See p. 111.) Also in Camden and Clinch Counties, in the flat country.

Delaware to Florida and Arkansas, in the coastal plain.

VERNONIA Schreb., Gen. Pl. **2:** 541. 1791.

V. oligophylla Mx., Fl. **2:** 94. 1803.

TATTNALL: Flat pine-barrens near Collins (*1002*); sandy west bank of Ohoopee River west of Reidsville, June 24, 1903. Fl. June–July. Seen once in Chatham County, once in Laurens, and once in Sumter. Rare.

North Carolina to Florida, in the pine-barrens.

V. angustifolia Mx., Fl. **2:** 94. 1803.

Dry pine-barrens and sand-hills; common in all the pine-barren region of Georgia. Also on the Pine Mountains of western Middle Georgia (see Bull. Torrey Club **30:** 294. 1903).

North Carolina to Florida, Arkansas, and Texas, mostly in the coastal plain.

V. sp. (related to *V. Noveboracensis*, but probably undescribed).

COFFEE: Damp shady woods near Douglas (*723*, *1424*). Fl. July–Sept.

AMBROSIACEÆ.

(All our species weeds.)

IVA L., Sp. Pl. 988. 1753.

I. MICROCEPHALA Nutt., Trans. Am. Phil. Soc. **7**: 346. 1840.

A roadside weed, not common. TELFAIR (several stations), IRWIN (Fitzgerald), DECATUR. Fl. September. More common in Dooly, Sumter, and Mitchell Counties, in the Lower Oligocene region. Also in a few places east of Okefinokee Swamp, and in Florida.

Natural range and habitat unknown.

AMBROSIA L., Sp. Pl. 987. 1753.

A. ARTEMISIÆFOLIA L., Sp. Pl. 988. 1753. RAGWEED.

In streets or around dwellings. TATTNALL: Collins; BERRIEN: Tifton. Fl. Aug.–Sept. Much commoner farther inland.

Widely distributed in North America, but natural range and habitat unknown.

XANTHIUM L., Sp. Pl. 987. 1753.

X. STRUMARIUM L., l. c. COCKLEBUR.

Streets of Tifton, Sept. 27, 1902. Very common farther inland, where it is often a pest in cultivated fields.

Widely distributed in Eastern North America, but natural range and habitat unknown.

LOBELIACEÆ.

LOBELIA L., Sp. Pl. 929. 1753.

L. cardinalis L., Sp. Pl. 930. 1753. (CARDINAL FLOWER)

COFFEE: Ocmulgee River swamp opposite Lumber City, Sept. 1, 1903. Fl. July–Sept. More common in the upper third of the coastal plain.

Widely distributed in the Eastern United States, but wanting over considerable areas.

L. glandulosa Walt., Fl. Car. 218. 1788.

Moist pine-barrens, not rare. COFFEE, IRWIN, BERRIEN, WORTH COLQUITT (*1663*). Fl. Aug.–Oct.

Virginia (?) to central Florida, in the pine-barrens.

L. flaccidifolia Small, Bull. Torrey Club **24**: 338. 1897.

Swamps of creeks and coastal plain (*i. e.*, not muddy) rivers.

TATTNALL, MONTGOMERY, TELFAIR, COLQUITT (*1676*). Fl. June–July. Also just outside of our territory in Johnson and Thomas Counties (discovered in the latter county by Dr. Small).

Not definitely known outside of Georgia. See Bull. Torrey Club **31**: 25. 1904.

L. **Boykinii** T. & G.; DC., Prodr. **7**: 374. 1839.

Cypress and other ponds, infrequent. COFFEE (*2199*), WILCOX Fl. May–June. More common in the Lower Oligocene region.

South Carolina to Florida, in the pine-barrens.

L. **Nuttallii** R. & S., Syst. **5**: 39. 1819.

Intermediate pine-barrens. EMANUEL (*814*), COFFEE, IRWIN (*1418*), COLQUITT, THOMAS. Inconspicuous, and doubtless grows elsewhere in the region, where it has been overlooked. Fl. June–July.

New Jersey to West Florida, mostly in the coastal plain.

CAMPANULACEÆ.

SPECULARIA Heist.; Fabr. Enum. Pl. Hort. Helmst. 121. 1759.

S. PERFOLIATA (L.) A. DC., Mon. Camp. 351. 1830.

A weed along the streets of Nashville, May 6, 1904.

Widely distributed in North America, but natural range and habitat unknown.

CAPRIFOLIACEÆ.

LONICERA L., Sp. Pl. 173. 1753.

L. **sempervirens** L., l. c. HONEYSUCKLE. WOODBINE.

Wooded bluffs along the muddy rivers (see pp. 27, 102). BULLOCH, MONTGOMERY. Fl. April–June. Also along the Flint and Chattahoochee Rivers in Southwest Georgia, and the Oconee River in Middle Georgia.

Widely distributed in the Eastern United States west of New England. Leaf-anatomy discussed by Kearney, Contr. U. S. Nat. Herb. **5**: 507, 508. 1901.

VIBURNUM L., Sp. Pl. 267. 1753.

V. **obovatum** Walt., Fl. Car. 116. 1788.

Swamps of rivers originating north of our territory. SCREVEN:

Ogeechee River; TATTNALL: Ohoopee River. Fl. March–April. Known from quite a number of stations in the Eocene and Lower Oligocene regions, also in Lowndes and Charlton Counties, nearer the coast.

Virginia to central and Middle Florida, in the coastal plain.

V. rufotomentosum Small, Bull. Torrey Club **23**:410. 1896. BLACK HAW.

? *V. rufidulum* Raf., Alsog. Am. 56. 1838. (See Sarg., Silva N. A. **14**:23. *pl. 710.* 1902.)

Bluffs and hammocks, along the rivers rising north of our territory. EMANUEL: Little Ohoopee River; MONTGOMERY: Oconee River; TELFAIR, COFFEE, WILCOX: Ocmulgee River. Fl. April–May.

Widely distributed in Georgia and the other southeastern states.

V. nudum L., Sp. Pl. 268. 1753.

Principally in branch-swamps; common throughout our territory, and to some extent coastward, but not known in the adjacent lime-sink region. Reappears near Americus and at a few stations in Middle Georgia.

Long Island to Florida and Louisiana, and in a few interior states.

V. nitidum Ait., Hort. Kew. **1**:371. 1789.; Mohr, Contr. U. S Nat. Herb. **6**:744. 1901.

In similar places to the preceding, but usually in larger swamps and much less common. BULLOCH (*831*), MONTGOMERY, COFFEE, IRWIN, BERRIEN. Fl. April. (See Bull. Torrey Club **30**:341. 1903.)

North Carolina to Florida and Mississippi, in the coastal plain.

SAMBUCUS L., Sp. Pl. 269. 1753.

S. CANADENSIS L., l. c. ELDER.

TELFAIR: Low grounds along railroad near Helena, July 3, 1903. Evidently not native. Common farther inland.

Widely distributed in Eastern North America, but its status as a native has been questioned by Dr. Gray (Am. Nat. **1**:493–494. 1867) and is worth looking into.

RUBIACEÆ.

GALIUM L., Sp. Pl. 105. 1753.

G. uniflorum Mx., Fl. 1:79. 1803.

In rich soil at the inland edge of our territory. WILCOX: Upper Seven Bluffs; DOOLY: Around lime-sink east of Wenona. Fl. May. Not seen nearer the coast, but extends inland to Sumter, Glascock, and Clarke Counties (see Bull. Torrey Club **27**:340. 1900).

South Carolina to Texas.

G. hispidulum Mx., l. c.

Sand-hills and hammocks. BULLOCH (*966*), COFFEE, IRWIN, THOMAS. Also farther inland.

New Jersey (?) to central Florida and Louisiana (?), in the coastal plain.

Leaf-anatomy discussed by Kearney, Contr. U. S. Nat. Herb. **5**:506–507. *f. 90.* 1901.

G. pilosum Ait., Hort. Kew. 1:145. 1789.

Dry pine-barrens, etc. BULLOCH (*947*), TATTNALL, COLQUITT.

Widely distributed in the Eastern United States.

DIODIA L., Sp. Pl. 104. 1753.

D. teres Walt., Fl. Car. 87. 1788.

Spermacoce hyssopifolia J. E. Smith, Abbot's Insects of Ga. 75. *pl. 38.* 1797.

One of our commonest roadside and railroad weeds. Grows in dry exposed places all over the state. On Altamaha Grit outcrops in TATTNALL possibly indigenous, Fl. May–Oct.

Widely distributed in the Eastern United States, but natural range and habitat uncertain.

D. sp. (near *D. Virginiana*, but probably undescribed).

BERRIEN: Margin of shallow pine-barren pond near Tifton, Sept. 26, 1902 (*1682*).

RICHARDIA L., Sp. Pl. 330. 1753.

R. SCABRA L., l. c.

Streets of Collins, June 25, 1903. Common in cultivated ground in Sumter, Lowndes, and some other counties in other parts of the coastal plain.

A native of the tropics, naturalized in the coastal plain from South Carolina to Florida and Mississippi.

MITCHELLA L., Sp. Pl. 111. 1753.

M. repens L., l. c. (PARTRIDGE BERRY.)

Bluffs, hammocks, etc. TATTNALL, MONTGOMERY, COFFEE, WILCOX, BERRIEN.

Common nearly throughout the Eastern United States.

CEPHALANTHUS L., Sp. Pl. 95. 1753.

C. occidentalis L., l. c. BUTTON BUSH. BUTTON WILLOW.

In creek- and river-swamps and around deep ponds; usually near permanent water. Grows in ponds near the Altamaha Grit escarpment in SCREVEN, WORTH, and DECATUR, and in the swamps of the Ogeechee, Ohoopee, Ocmulgee, and other large streams. Fl. all summer.

Nearly throughout the Eastern United States and in the neighboring tropics.

PINCKNEYA Mx., Fl. 1: 105. *pl. 13.* 1803.

P. pubens Mx., l. c. "MAIDEN'S BLUSHES." "PERUVIAN." (KENTUCKY MAGNOLIA).

Mussaenda bracteolata Bartr.; Humboldt, Ideen zu einer Geographie der Pflanzen, 70. 1807.

Branch-swamps and sand-hill streams throughout. Fl. June–July. Wanting in the adjacent lime-sink region, but reappears at several points in and near Americus, the only stations known north of the Altamaha Grit escarpment. (See Bull. Torrey Club **27**: 435. 1900; **32**: 147. 1905.) Extends southeast to within 20 miles of the coast in Chatham and Glynn Counties.

Ranges from extreme southern South Carolina to Middle Florida. More abundant in the Altamaha Grit region than in all the rest of its range combined. (See Torreya **5**: 114. 1905).

HOUSTONIA L., Sp. Pl. 105. 1753.

H. longifolia Gaert., Fr. & Sem. 1: 226. *pl. 49. f. 8.* 1788.

Bluffs, rock outcrops, etc., infrequent. TATTNALL, MONTGOMERY, COFFEE. Fl. May–Nov. More common farther inland.

Widely distributed in Eastern North America north of lat. 32°.

H. rotundifolia Mx., Fl. 1: 85. 1803.

Sand-hills and dry pine-barrens. SCREVEN, BULLOCH, MONTGOMERY, COFFEE, IRWIN, BERRIEN. Fl. Feb.–April. Inland to Johnson and Stewart Counties.

South Carolina to central Florida and Louisiana, in the pine-barrens.

OLDENLANDIA L., Sp. Pl. 119. 1753.

O. uniflora L., l. c.

Moist or rather dry pine-barrens. COFFEE (*711*), THOMAS. Fl. Aug.–Sept. Extends inland to Sumter County and coastward to McIntosh.

Long Island to South Florida and Louisiana in the coastal plain, mostly in the pine-barrens.

PLANTAGINACEÆ.

PLANTAGO L., Sp. Pl 112. 1753.

P. ARISTATA Mx., Fl. 1 : 95. 1803.

A weed in the streets of Collins and Fitzgerald. Fl. May–June. More common in some of the older cities farther inland.

Widely distributed in the Eastern United States, perhaps native westward.

BIGNONIACEÆ.

TECOMA Juss., Gen. 139. 1789.

T. radicans (L). DC., Prodr. 9 : 223. 1845. COW ITCH.

Rock outcrops in TATTNALL and creek- and river-swamps in MONTGOMERY and COFFEE. Fl. May–Oct. More frequent in Middle Georgia and the upper third of the coastal plain, but there usually as a weed, particularly around fences and stumps in fields.

Widely distributed in the Southeastern United States, but natural range uncertain.

BIGNONIA L., Sp. Pl. 622. 1753.

B. crucigera L., Sp. Pl. 624 (=*B. capreolata* L., l. c.) CROSS-VINE.

Chiefly in creek-swamps, occasionally also along branches and rivers. SCREVEN, BULLOCH, EMANUEL, MONTGOMERY, DODGE,

COFFEE, BERRIEN, COLQUITT (*1674*). Fl. March–May. Farther inland its habitat is more varied.

Nearly throughout the Southeastern United States except in the mountains (and probably not common in Florida, as it prefers shade).

OROBANCHACEÆ.

CONOPHOLIS Wallr., Orob. 78. 1825.

C. Americana (L.) Wallr. l. c.

In rich woods along bluffs and ravines at the extreme inland edge of our territory, and not properly belonging to this flora. BULLOCH: Bluff along Ogeechee River near Echo (*2091*); DECATUR: Ravine near Faceville (*1933*). Fl. March–April. Occurs also a short distance south of our territory, in Thomas County. More frequent in the Palæozoic, Cretaceous, and Eocene regions, but not known in Middle Georgia.

Widely distributed in the Eastern United States, but apparently wanting over considerable areas.

LENTIBULARIACEÆ.

UTRICULARIA L., Sp. Pl. 18. 1753.

U. cornuta Mx., Fl. 1 : 12. 1803.

Moist pine-barrens. COFFEE, WILCOX (abundant at several stations). Fl. May–July. Known also from Sumter, Early, and Decatur Counties in the Lower Oligocene region.

From Newfoundland west to Minnesota and Iowa in the glaciated region, and south to central Florida (?) and Louisiana in the coastal plain. (See Rhodora **7** : 76. 1905.)

U. juncea Vahl, Enum. 1 : 202. 1805.

Moist pine-barrens. DODGE, COFFEE (*673*), IRWIN, BERRIEN, DOOLY, COLQUITT. Fl. July–Sept. Inland to Sumter County and coastward to Okefinokee Swamp and vicinity.

Long Island to central Florida and Texas (?), in the coastal plain. Also in the West Indies and South America.

U. subulata L., Sp. Pl. 18. 1753.

Moist pine-barrens and edges of branch-swamps, sand-hill bogs, and rock outcrops. EMANUEL, TATTNALL, MONTGOMERY,

IRWIN, BERRIEN. Fl. April–July. Inland to Sumter County.
Massachusetts to Florida, Arkansas, and Texas, in the coastal plain. Also in the West Indies and South America.

U. macrorhyncha Barnhart Bull. Torrey Club, **25**: 515. 1898.
Moist pine-barrens. BULLOCH, MONTGOMERY, COFFEE, IRWIN, BERRIEN. Fl. April–Sept. Inland to Sumter County.
Also in Florida and perhaps Alabama.

U. inflata Walt. Fl. Car. 64. 1788. MILL-WHEEL (S. W. Ga.)
In small permanent ponds along the Altamaha Grit escarpment, and therefore not properly belonging to our flora. SCREVEN (*2086*), WILCOX. Fl. March–July. More common in the Lower Oligocene region.
Maine to Florida, Tennessee, and Texas, in the glaciated region and coastal plain, but not always indigenous. (See Rhodora **7** : 76. 1905.)

PINGUICULA L., Sp. Pl. 17. 1753.

P. lutea Walt., Fl. Car. 63. 1788.
Moist or rather dry (intermediate) pine-barrens. SCREVEN (*2085*), BULLOCH (*889*), EMANUEL. Fl. April. Also in Sumter County.
North Carolina to central Florida and Louisiana, in the pine-barrens.

P. elatior Mx., Fl. **1**: 11. 1803.
Moist pine-barrens. SCREVEN, BULLOCH, TATTNALL, MONTGOMERY (*2145*), WILCOX, IRWIN, BERRIEN. Fl. March-May. Not known farther inland, but extends down into the flat country almost to the coast.
North Carolina to central Florida and Alabama (?), in the pine-barrens.

P. pumila Mx., l. c.
Moist or rather dry pine-barrens. COFFEE (*2192*), BERRIEN. Fl. April–May. Not noted elsewhere in the state, but it is so inconspicuous that it is easily overlooked, especially when not in flower.
South Carolina to central Florida and Louisiana, in the pine-barrens.

ACANTHACEÆ.

RUELLIA L., Sp. Pl. 634. 1753.

(?) **R. humilis** Nutt., Trans. Am. Phil. Soc. II. 5:182. 1834.
Dry pine-barrens and sand-hills, rare. BULLOCH, TATTNALL. Fl. June.
West to Arkansas and Texas.

CALOPHANES D. Don; Sweet, Brit. Fl. Gard. II. *pl. 81.* 1833.

C. oblongifolia (Mx.) Don, l. c.
Sand-hills and dry pine-barrens, not rare. BULLOCH, COFFEE, WILCOX, BERRIEN. Fl. April–June. Extends inland to the fall-line sand-hills of Richmond and Columbia Counties.
Virginia to Florida, in the coastal plain.

C. humistrata (Mx.) Shuttl.; Nees in DC. Prodr. 11:108. 1847.
MONTGOMERY: Oconee River swamp near Mount Vernon. Fl. June. More abundant in the Ogeechee River swamp near Millen, a few miles north of our territory.
Also reported from Florida.

SCROPHULARIACEÆ.

BUCHNERA L., Sp. Pl. 630. 1753.

B. elongata Sw., Prodr. 92. 1788.
Dry pine-barrens; rather rare. BULLOCH, COFFEE. Fl. May–Aug. Inland to Sumter County and coastward to Charlton.
South Carolina to South Florida and Texas, in the coastal plain. Also in the West Indies and South America. (See notes under *Andropogon tener.*)

GERARDIA L., Sp. Pl. 610. 1753.

G. setacea Walt., Fl. Car. 170. 1788.
Chiefly in dry pine-barrens. APPLING, COFFEE (*2012*), IRWIN, BERRIEN, COLQUITT (*1658*). Fl. Sept.–Oct.
New Jersey to Florida and Texas, in the pine-barrens.

G. filifolia Nutt., Gen. 2:48. 1818
Dry pine-barrens and sand-hills. EMANUEL, TATTNALL, MONT-

GOMERY, TELFAIR, IRWIN, BERRIEN, WORTH, COLQUITT (*1669*). Fl. Sept.–Oct. Also in the flat pine-barren region, and in Sumter County.

South to Florida, west to Louisiana (?), in the pine-barrens.

G. Skinneriana Wood, Class Book 408. 1847.

Normally in intermediate pine-barrens. COFFEE (*704*), BERRIEN, WORTH, COLQUITT (*1670*). Fl. Sept.–Oct. Also in Sumter County.

From Massachusetts west to Minnesota and Iowa in the glaciated region, south to central Florida and Louisiana in the coastal plain. (See Rhodora **7**: 75. 1905.)

G. paupercula [Gray] Britton, Mem. Torrey Club **5**: 295. 1894.

Moist pine-barrens. IRWIN, BERRIEN, WORTH, COLQUITT. Fl. Sept.–Oct. Also a little outside of our territory in Dooly and Thomas Counties.

Widely distributed in the glaciated region of the north, but distribution southward not well worked out.

G. purpurea L., Sp. Pl. 610. 1753.

IRWIN: Moist pine-barrens in and near Fitzgerald, Oct. 4, 1902. (*1710*). Fl. Sept.–Oct. More frequent farther inland.

Widely distributed in the Eastern United States Also in the Bahamas (*Northrop*).

G. filicaulis [Benth.] Chapm., Fl. 299. 1860.

WORTH: Rather dry pine-barrens, more grassy than usual, near Tyty, Sept. 30, 1902. (*1698*).

Known also from Florida and Louisiana.

G. aphylla Nutt., Gen. **2**: 47. 1818.

Intermediate and moist pine-barrens. COFFEE (*703*), IRWIN, BERRIEN, WORTH, COLQUITT. Fl. Sept.–Oct. Also seen at least once in the flat pine-barrens, in McIntosh County.

North Carolina (?) to northeastern Florida and Louisiana, in the pine-barrens.

G. linifolia Nutt., Gen. **2**: 47. 1818.

Moist pine-barrens and shallow ponds, not common. TELFAIR, APPLING, DOOLY, BERRIEN, COLQUITT, THOMAS. Fl. Aug.–

Sept. Inland to Sumter County and coastward to McIntosh and Okefinokee Swamp and vicinity.

Delaware to Florida in the coastal plain, mostly in the pine-barrens.

DASYSTOMA Raf., Jour. Phys. **89**: 99. 1819.

D. pectinata (Nutt.) Benth. in DC. Prodr. **10**: 521. 1846.

Sand-hills and oak ridges. TATTNALL, MONTGOMERY, COFFEE, WILCOX, COLQUITT, BERRIEN. Fl. Aug.–Sept. Ranges inland to the mountains of Northwest Georgia (see Torreya **5**: 56. 1905), and sparingly coastward.

North Carolina to Florida and Arkansas, mostly in the coastal plain.

AFZELIA J. F. Gmel., Syst. **2**: 927. 1791.

SEYMERIA Pursh. Fl. 736. 1814.

A. pectinata (Pursh) Kuntze, Rev. **2**: 457. 1891.

Same habitat as the preceding, and often associated with it. MONTGOMERY, COFFEE, BERRIEN, COLQUITT, THOMAS. Fl. Aug.–Sept.

South Carolina to central Florida and Texas, in the coastal plain.

A. cassioides (Walt.) Gmel., l. c.

Seymeria tenuifolia Pursh, Fl. 737. 1814.

Rather dry (especially if flat) or moist pine-barrens, or even on rock outcrops, throughout our territory and to some extent coastward. Fl. Aug. Sept.

North Carolina to central Florida and Texas, mostly in the pine-barrens. Also in the Bahamas (*Britton*).

MACRANTHERA Torr.; Benth. in Hook. Comp. Bot. Mag. **1**: 203. 1835.

CONRADIA Nutt., Jour. Acad. Phila. **7**: 88. *pl. 11, 12*. 1834. (Not Mart. 1829.)

M. fuchsioides (Nutt.) Torr., l. c.

In branch-swamps, sometimes eight feet tall. IRWIN, BERRIEN, WORTH, COLQUITT, THOMAS. Fl. Sept.–Oct.

South to Florida and west to Louisiana, in the coastal plain.

VERONICA L., Sp. Pl. 9. 1753.

V. PEREGRINA L., Sp. Pl. 14. 1753.

A weed in Swainsboro, April 6, 1904. More common in Middle Georgia.

Widely distributed in the Northern Hemisphere, but natural range and habitat unknown. Perhaps of European origin.

SCOPARIA L., Sp. Pl. 116. 1753.

S. DULCIS L., l. c.

A weed in the streets of Douglas, in rather damp soil. Fl. Aug.–Sept.

More common in similar situations nearer the coast (McIntosh, Glynn, Camden, Lowndes, and Decatur Counties).

Georgia and Florida to Texas; also in the tropics, where it probably originated.

ILYSANTHES Raf., Ann. Nat. 13. 1820.

I. **refracta** (Ell.) Benth. in DC. Prodr. **10**: 418. 1846.

Usually in small branch-swamps and in moist places on rock outcrops. TATTNALL, DODGE, COFFEE, IRWIN, DOOLY. Fl. April–July. Also on damp rocks in Middle Georgia and the mountains of Alabama (Mohr), and a weed in ditches along railroads near Americus. Around mayhaw ponds and in moist pine-barrens in Sumter and Lee Counties.

North Carolina to Mississippi.

I. GRATIOLOIDES (L.) Benth. in DC. Prodr. **10**: 419. 1846.

BULLOCH: A weed along damp roadsides near Bloys, June 11, 1901.

Widely distributed in the United States, Asia, and South America. Natural range and habitat uncertain.

SOPHRONANTHE Benth.; Lindl., Intr. Nat. Syst. ed. 2, 445. 1836.

S. **hispida** Benth., l. c.

Gratiola subulata Baldw.; Benth. in DC. Prodr. **10**: 405. 1846.

Rather dry flat pine-barrens, and corresponding places on sand-hills (see p. 89). TATTNALL, APPLING, COFFEE,

(*689, 1444*). Fl. July–Sept. Also in similar places nearer the coast, but not known farther inland.

South to central Florida, west to Louisiana, in the pine-barrens.

S. pilosa (Mx.) Small, Fl. 1067. 1903.

Gratiola pilosa Mx., Fl. **1**:7. 1803.

Intermediate and moist pine-barrens. BULLOCH, MONTGOMERY, DODGE, COFFEE, IRWIN, THOMAS, DECATUR. Fl. June–Aug. Pretty widely distributed in the coastal plain, and also occurring in Meriwether County with other coastal plain plants. (See Bull. Torrey Club **30**:294. 1903.)

New Jersey to central Florida and Texas, mostly in the coastal plain. Also in the mountains of Alabama (*Mohr*).

GRATIOLA L., Sp. Pl. 17. 1753.

G. ramosa Walt., Fl. Car. 61. 1788.

G. quadridentata Mx., Fl. **1**:6. 1803.

Small branch-swamps and shallow ponds. BULLOCH (*840*), COFFEE, WILCOX, IRWIN, BERRIEN, DOOLY, COLQUITT. Fl. summer. Common in the Lower Oligocene region.

South Carolina to central Florida, in the pine-barrens.

G. sphærocarpa Ell., Sk. **1**:14. 1816.

BULLOCH: Wet woods near Bloys, June 15, 1901. Fl. March–April (in Middle Georgia, where it is more common).

New Jersey to Illinois, Florida, and Mexico.

MONNIERA P. Br., Hist. Jam. 269. *pl. 28. f. 3.* 1756.

M. Caroliniana (Walt.) Kuntze, Rev. **2**:463. 1891.

Herpestis amplexicaulis (Mx.) Pursh. Fl. 418. 1814.

BERRIEN: Shallow pond near Tifton, Oct. 2, 1902. Fl. all summer. Not seen nearer the coast, but common in the Lower Oligocene region. Also occurs in a pond near Omaha, Stewart Co., which is not far from the only station reported for it in Alabama by Dr. Mohr. (See Contr. U. S. Nat. Herb. **6**:722. 1901; Bull. Torrey Club **32**:457. 1905.)

Said to range from Maryland to Florida and Louisiana in the coastal plain, but there are evidently some considerable gaps in its known range.

PENTSTEMON Soland. in Ait. Hort. Kew. **3**:511. 1789.

P. multiflorus Chapm.; Small, Fl. 1061. 1903.

APPLING: Dry sandy places around Big Pond, Sept. 12, 1903. IRWIN: Sand-hills of Allapaha River (seen from train), Oct. 3, 1902. Fl. Aug.-Oct. Also occurs around the large ponds of Decatur County, in the lime-sink region. Also in Florida.

P. pallidus Small, Fl. 1060. 1903.

COFFEE: Moist hillside near Altamaha Grit outcrops along Ocmulgee River opposite Lumber City, Sept. 11, 1903. (See p. 113).

"New York to Missouri, Georgia, and the Indian Territory."

P. hirsutus (L.) Willd. Sp. Pl. **3**:227. 1801.

Normally in dry pine-barrens. BULLOCH (*826*), TATTNALL, MONTGOMERY, COFFEE, WILCOX, BERRIEN. Fl. April–June. Common in Middle Georgia.

Widely distributed in the Eastern United States.

P. dissectus Ell., Sk. **2**:129. 1822.

On rock outcrops in TATTNALL (*1856, 2158*) and DOOLY. Also in sandy places in TATTNALL, MONTGOMERY, and WILCOX (*2208*), where the local geological conditions are imperfectly understood. Fl. April–May. These are all the known stations for this species. For additional notes on it see Bull. Torrey Club **32**:166, 167. 1905, Torreya, **5**:114. 1905.

LINARIA Juss., Gen. Pl. 120. 1789.

L. Floridana Chapm., Fl. 290. 1860.

Rosemary sand-hills in EMANUEL (*976*), and base of sand-hills of Ohoopee River in TATTNALL. Evidently flowers early.

Known otherwise only from the coast of Alabama and West Florida. (See Bull. Torrey Club **30**:340. 1903.)

L. CANADENSIS (L.) Dumont, Bot. Cult. **2**:96. 1802.

A weed, most frequent in cultivated fields. SCREVEN, BULLOCH, TATTNALL, BERRIEN. Fl. March–April. Common in Middle Georgia.

Widely distributed in North America, but natural range and habitat unknown.

VERBASCUM L., Sp. Pl. 177. 1753.

V. THAPSUS L., l. c. MULLEIN.

Seen only at Pitts, WILCOX Co., in 1902 and 1903. More common in long-settled regions.

Widely distributed in North America, also in Europe, where it is perhaps native.

V. BLATTARIA L., Sp. Pl. 178. 1753.

Seen from a train at Ogeechee, SCREVEN Co., June 4, 1901.

Distribution similar to that of the preceding.

LABIATÆ.

MESOSPHÆRUM P. Br., Hist. Jam. 257. 1756.

M. radiatum (Willd.) Kuntze, Rev. 525. 1891.

M. rugosum (L.) Pollard, not *M. rugosum* (Benth.) Kuntze.

Moist pine-barrens and edges of branch-swamps, often where the Lafayette formation seems to be absent. DODGE, APPLING, COFFEE, WILCOX, IRWIN, BERRIEN, DOOLY, WORTH, COLQUITT, THOMAS. Fl. June–Aug. Not observed east of the Oconee and Altamaha Rivers, but common west of them, from Sumter County nearly to the coast.

North Carolina (?) to South Florida and Texas, in the coastal plain. Also in the tropics.

PERILLA Ard.; L. Gen. Pl. ed. 6. Add. 578. 1764.

P. FRUTESCENS (L.) Britton, Mem. Torrey Club 5:277. 1894.

TATTNALL: Roadside just west of the Ohoopee River near the center of the county, June 24, 1903.

Native of Asia, naturalized (escaped?) in several places in the Eastern United States.

LYCOPUS L., Sp. Pl. 21. 1753.

L. rubellus Moench, Meth. Suppl. 146. 1802.

COFFEE: Ocmulgee River swamp opposite Lumber City, Sept. 11, 1903. (*1991*).

New York to Florida, Missouri, and Louisiana.

L. pubens Britton; Small, Fl. 1049. 1903.

Moist pine-barrens and shallow ponds. IRWIN, BERRIEN, WORTH, COLQUITT (*1648*). Fl. Sept.–Oct.

South to northeastern Florida, west to Mississippi (?), in the pine-barrens.

KŒLLIA Moench, Meth. 417. 1794.

K. hyssopifolia (Benth.) Britton, Mem. Torrey Club **5**: 279. 1894.
In and near branch-swamps and shallow ponds. BULLOCH (*837*), COFFEE.
Virginia (?) to Middle Florida and Louisiana (?), in the coastal plain.

K. nuda (Nutt.) Kuntze, Rev. **2**: 520. 1891.
Intermediate and moist pine-barrens. COFFEE (*680*), IRWIN, BERRIEN, COLQUITT.
Distribution not well understood. Originally described from the "mountains of Carolina and Georgia," but now known only from the pine-barrens of South Carolina, Georgia, northern Florida, and Alabama.

DICERANDRA Benth., Bot. Reg. **15**: (under *pl. 1300*). 1829.

D. odoratissima Harper, Bull. Torrey Club, **28**: 479. *pl. 29. f. 3.* 1901.

(PLATE 18, FIG. 2.)

Sand-hills, particularly toward the hammocks at their bases. BULLOCH (?), TATTNALL, COFFEE (*695*, type), WILCOX, BERRIEN (*1695*). Fl. Sept.-Oct. Known otherwise only from similar situations in Liberty, Pierce, and Ware Counties, in the flat country. For additional notes see Bull. Torrey Club **31**: 25. 1904; **32**: 166. 1905; Torreya **5**: 114. 1905.

D. linearifolia (Ell.) Benth. in DC Prodr. **12**: 243. 1848.
Habitat similar to that of the preceding. EMANUEL, MONTGOMERY, DODGE, IRWIN, BERRIEN (*1699*). Fl. Sept.–Oct. All the flowering specimens I have seen in this region have corollas colored like those of *D. odoratissima* (white with purple spots), but elsewhere the normal color is pink-purple. Common in dry pine-barrens in the lime-sink region, also on the fall-line sand-hills in Taylor County, where Elliott discovered it. (See Bull. Torrey Club **31**: 12. 1904.)
Known also from the pine-barrens of Florida (?) and Alabama.

CLINOPODIUM L., Sp. Pl. 587. 1753.
Our species shrubs.

C. Georgianum Harper, Bull. Torrey Club **33**: 243. 1906.
C. Carolinianum (Mx.) Heller, Cat. 7. 1898; not Mill., 1768.

MONTGOMERY: Bluff along Oconee River near Ochwalkee. DODGE: Hammock of Gum Swamp Creek east of Eastman. Fl. Sept.–Oct. More common in the upper parts of the coastal plain, and in Middle Georgia.

North Carolina (?) to Florida (River Junction) and Mississippi (?), in the Piedmont region and coastal plain.

C. coccineum (Nutt.) Kuntze, Rev. **2**: 515. 1891.

Sand-hills and sand-hammocks. EMANUEL (*981*), TATTNALL (seen once), MONTGOMERY (*1872*). Flowers all summer, and perhaps throughout the year.

Known otherwise only from West Florida and southwestern Alabama.

SALVIA L., Sp. Pl. 23. 1753.

S. lyrata L., l. c.

Dry pine-barrens, etc.; not common. BULLOCH, TATTNALL, MONTGOMERY, WILCOX, DOOLY. Fl. April–May. Also in Middle Georgia.

New Jersey to Missouri, central Florida, and Texas.

S. azurea Lam., Jour. Nat. Hist. **1**: 409. 1792.

Dry pine-barrens and sand-hills. COFFEE, IRWIN, BERRIEN (*1705*), WORTH, COLQUITT. Fl. Sept.–Oct. Also inland to Middle Georgia.

South Carolina to Florida (?), Arkansas and Texas.

PHYSOSTEGIA Benth., Lab. 504. 1834.

P. denticulata (Ait.) Britton, Mem. Torrey Club **5**: 284. 1894.

Moist pine-barrens, mostly near creeks. BULLOCH (*891*), TATTNALL, COFFEE. Fl. June, July.

Virginia to central Florida and Texas (?) in the coastal plain.

SCUTELLARIA L., Sp. Pl. 598. 1753.

S. multiglandulosa [Kearney] Small; Harper, Bull. Torrey Club **27**: 339. 1900.

Dry pine-barrens. BULLOCH (*822*), EMANUEL, WILCOX, IRWIN, DECATUR. Fl. May–June.

Also in Middle Georgia, Florida, and perhaps Alabama.

S. integrifolia L., Sp. Pl. 599. 1753.
BULLOCH: Edge of branch-swamp near Bloys, June 15, 1901. (*885*).
Widely distributed in the Eastern United States.

S. pilosa Mx., Fl. 2:11. 1803.
MONTGOMERY: Dry woods along Oconee River near Mount Vernon, June 29, 1903. Also in Middle Georgia.
Range about the same as that of the preceding.

S. Mellichampii Small, Fl. 1022. 1903.
MONTGOMERY: Bluff along Oconee River near Ochwalkee, July 1, 1903. Also occurs on the same side of the same river near Dublin, in the next county above.
Known otherwise only from the type-locality in the southern corner of South Carolina.

S. lateriflora L., Sp. Pl. 598. 1753.
COFFEE: Ocmulgee River swamp opposite Lumber City, Sept. 11, 1903.
Widely distributed east of the Rocky Mountains.

TRICHOSTEMA L., Sp. Pl. 598. 1753.

T. lineare Nutt., Gen. **2**:39. 1818.
Sand-hills, dry pine-barrens, and rock outcrops. DODGE, COFFEE, IRWIN (*1703*), DOOLY, COLQUITT. Fl. Aug.–Oct. Also in Middle Georgia.
Connecticut to Florida, Arkansas, and Louisiana.

VERBENACEÆ.

CALLICARPA L., Sp. Pl. 111. 1753.

C. Americana L., l. c. FRENCH MULBERRY.
Hammocks, river-bluffs, etc., BULLOCH, TATTNALL, MONTGOMERY, DODGE, WILCOX, COFFEE, BERRIEN. Fl. June–July. Grows nearly all over Georgia, but only as a ruderal plant in some places.
Ranges nearly throughout the Southeastern United States except in the higher mountains.

VERBENA L., Sp. Pl. 18. 1753.

V. carnea Med.; Schauer in DC. Prodr. **11**:545. 1847. (See Bull. Torrey Club **33**:242. 1906.)

V. Carolina, *Caroliniana*, and *Carolinensis* of authors.

Sand-hills and dry pine-barrens. EMANUEL, TATTNALL, MONTGOMERY, COFFEE, BERRIEN, COLQUITT. Fl. April–July. Also farther inland.

North Carolina to central Florida and Mexico (?), in the coastal plain.

V. BRACTEOSA Mx., Fl. 2 : 13. 1803.

A roadside weed. EMANUEL: Graymont; WILCOX: Pitts. Fl. May–Aug.

British Columbia to Florida. Perhaps native on the prairies, where Michaux discovered it.

BORRAGINACEÆ.

BATSCHIA Gmel. Syst. 2 : 315. 1791.

B. Carolinensis (Walt.) Gmel., l. c. (See Bull. Torrey Club, **33**: 241. 1906.)

Lithospermum hirtum Lehm., Asperif. 305. 1818.

L. Gmelini (Mx.) Hitchcock, Spring Fl. Manh. 30. 1894.

BERRIEN: Sand-hills of Allapaha River (*2189*). Fl. April–June. Also extends inland to the fall-line sand-hills, but not common in Georgia.

Widely scattered east of the Rocky Mountains, but distribution not well understood.

ONOSMODIUM Mx., Fl. 1: 132. 1803.

O. Virginianum (L.) A. DC., Prodr. 10: 70. 1846; Mackenzie, Bull. Torrey Club, 32 : 497–499. 1905.

BERRIEN: With the preceding, May 5, 1904; also in dry pine-barrens near Tifton. IRWIN: Dry pine-barrens near Fitzgerald. Fl. May–June. Also inland to Middle Georgia.

Connecticut to Florida and Louisiana, mostly in the coastal plain and Piedmont region.

SOLANACEÆ.

All our species weeds.

SOLANUM L., Sp. Pl. 184. 1753.

S. NIGRUM L., Sp. Pl. 186. 1753.

BULLOCH: Near Bloys, June 12, 1901.

Cosmopolitan, but natural range and habitat unknown.

S. CAROLINENSE L., Sp. Pl. 187. 1753.

A weed in the streets of our three largest cities, Fitzgerald, Tifton and Moultrie. Fl. May–Oct. Very common in the upper parts of the state.

Widely distributed in the Eastern United States, but natural range and habitat unknown.

S. ROSTRATUM Dunal, Sol. 234. *pl. 24.* 1813.

Around dwellings, etc. EMANUEL: Graymont; WILCOX: Pitts, Queensland.

Introduced from the western plains.

DATURA L., Sp. Pl. 179. 1753. "JIMSON WEED."

D. TATULA L., Sp. Pl. ed. 2, 256. 1762.

Near dwellings. MONTGOMERY: Ailey; WILCOX: Queensland. Common in the older-settled parts of the state.

Widely distributed in the Eastern United States, also in South America, where it probably originated.

D. STRAMONIUM L., Sp. Pl. 179. 1753.

BULLOCH: Near Bloys, June 12, 1901. Much rarer in the South than the preceding, but said to be more widely distributed in the tropics. It may be doubted whether these two forms are specifically distinct. (See Tully, Am. Jour. Sci. **6**: 254–258. 1823). Perhaps *D. Tatula* is a native of the New World and *D. Stramonium* of the Old World.

POLEMONIACEÆ.

PHLOX L., Sp. Pl. 151. 1753.

P. subulata L., Sp. Pl. 152. 1753. (Including *P. Hentzii* Nutt.)

Dry pine-barrens, sand-hills, etc.; frequent but not abundant. BULLOCH (*827*), EMANUEL, TATTNALL, MONTGOMERY, COFFEE, WILCOX, IRWIN, BERRIEN. Fl. March–June. Inland to Middle Georgia.

New York to Michigan and Georgia.

P. amœna Sims, Bot. Mag. **31**: *pl. 1308.* 1810. (Including *P. Walteri* (Gray) Chapm. and *P. Lighthipei* Small.)

Dry pine-barrens. BULLOCH (*2163*), COFFEE, WILCOX. Fl. April–June. Frequent in Middle Georgia.

Widely distributed in the Southeastern United States.

CUSCUTACEÆ.

CUSCUTA L., Sp. Pl. 124. 1753.

C. indecora Choisy, Mem. Soc. Genev. 9 : 278. *pl. 3. f. 5.* 1841.

COLQUITT: On a considerable variety of herbs, in moist pine-barrens, at two or three places near Moultrie (*1650.*) Fl. September. Not seen elsewhere in Georgia.

Ranges mostly westward, but distribution not well worked out.

C. compacta Juss., Choisy, l. c. 9: 281. *pl. 4. f. 2.* 1841. LOVE VINE.

On shrubs, mostly in swamps. DOOLY, COFFEE, BERRIEN, COLQUITT. Fl. September. Pretty well distributed over the state, perhaps less common eastward.

Widely distributed in the Eastern United States, but probably not everywhere native.

CONVOLVULACEÆ.

BREWERIA R. Br., Prodr. 1 : 487. 1810.

B. humistrata (Walt.) Gray, Syn. Fl. 2 : 217. 1878.

Dry pine-barrens, sand-hills, etc. BULLOCH, TATTNALL, MONTGOMERY, COFFEE, IRWIN, BERRIEN, COLQUITT. Fl. May–Sept. Inland to Middle Georgia (see Bull. Torrey Club 27: 328. 1900) and coastward to Cumberland Island. Varies considerably in the width of its leaves.

Virginia to Florida and Louisiana, mostly in the coastal plain.

B. aquatica (Walt.) Gray, l. c.

Around shallow ponds (not cypress ponds. See p. 79). BULLOCH, IRWIN, BERRIEN, COLQUITT. Fl. June–July. More common in the Lower Oligocene region.

Virginia (?) to central Florida and Texas (?), in the coastal plain; but the only Alabama station reported by Dr. Mohr is in the Palæozoic region. There are evidently some surprising gaps in its known range.

DICHONDRA Forst., Char. Gen. Pl. 39. *pl. 40.* 1776.

D. Carolinensis Mx., Fl. 1 : 136. 1803.

TELFAIR: Ocmulgee River swamp near Lumber City, Sept. 11, 1903. Not free from the suspicion of being introduced. In

Sumter and Thomas Counties, outside of our territory, I have seen it in places where it cannot possibly be indigenous.

Said to range from Virginia to Florida and Texas in the coastal plain, and throughout the tropics.

ASCLEPIADACEÆ.

ANANTHERIX Nutt., Gen. 1 : 169. 1818.

A. connivens (Baldw.) Feay; Wood, Class-Book, 594. 1861.

Moist pine-barrens, rather rare. (See Bull. Torrey Club, **31**: 24, 25. 1904.) COFFEE (*1420*), IRWIN, BERRIEN, DOOLY, COLQUITT. Fl. July. Also nearer the coast in Charlton and Lowndes Counties, and in central Florida, but not known farther inland.

ASCLEPIAS L., Sp. Pl. 214. 1753.

A. cinerea Walt., Fl. Car. 105. 1788.

Dry or intermediate pine-barrens, frequent throughout, but nowhere abundant. Fl. June–July. Inland to Johnson, Dooly, and Lee Counties, and coastward nearly to the south-eastern corner of the state.

South Carolina to central Florida, in the pine-barrens.

A. Michauxii Decne. in DC. Prodr. **8** : 569. 1844.

Intermediate pine-barrens; scarce; rarely more than one or two specimens visible at a time. BULLOCH, BERRIEN. Fl. April–June.

South Carolina to northeastern Florida and Mississippi, in the pine-barrens.

A. verticillata L., Sp. Pl. 217. 1753.

Dry pine-barrens; rather rare. EMANUEL, MONTGOMERY. More common farther inland, almost anywhere in the upper parts of the state, where it flowers all summer.

Widely distributed in the Eastern United States.

Root-anatomy discussed by W. E. Britton, Bull. Torrey Club **30** : 608–609. 1903.

A. perennis Walt., Fl. Car. 107. 1788.

MONTGOMERY: Oconee River swamp near Mount Vernon, June 27, 1903. More common in similar situations in the

Lower Oligocene region, where it flowers from May to August. Seen once on the St. Mary's River near Traders Hill.

South Carolina to Florida, Mississippi, Indiana, Arkansas, and Texas, mostly in the coastal plain.

A. lanceolata Walt., Fl. Car. 107. 1788.

Edges of branch- and creek-swamps. TELFAIR, COFFEE, IRWIN, DOOLY. June–Aug. Pretty widely distributed through the pine-barrens of Georgia, but nowhere abundant.

New Jersey to central Florida and Texas, in the pine-barrens.

A. variegata L., Sp. Pl. 215. 1753.

WILCOX: Upper Seven Bluffs on the Ocmulgee River, May 17, 1904. Hardly belongs to our flora. More common in the upper third of the coastal plain, and in Middle Georgia, where it flowers in May and June. Also reported from Thomas County, just south of our territory (*Mrs. Taylor*).

Widely distributed in the Eastern United States south of lat. 41°

(PLATE 19, FIG. 1).

A. humistrata Walt., Fl. Car. 105. 1788.

A. amplexicaulis Mx., Fl. **1** : 115. 1803. (Not of J. E. Smith.)

Sand-hills and very dry pine-barrens; not abundant. BULLOCH (*833*), TATTNALL, MONTGOMERY, WILCOX, IRWIN, BERRIEN. Fl. April–June. Pretty well distributed over South Georgia, but scattered, and probably not always indigenous. (For morphological notes see Bull. Torrey Club **30** : 339. 1903.)

North Carolina to central Florida and Mississippi, in the coastal plain.

A. tuberosa L., Sp. Pl. 217. 1753.

Dry pine-barrens and sand-hills; not common. BULLOCH, MONTGOMERY, COFFEE. Fl. May–Sept. More common in Middle and Southwest Georgia.

Widely distributed east of the Rocky Mountains, but often only a weed.

PODOSTIGMA Ell., Sk. **1** : 326. 1817.

STYLANDRA Nutt., Gen. **1** : 170. 1818.

P. pedicellata (Walt.) Vail; Small, Fl. 939. 1903.

P. pubescens Ell., l. c.

S. pumila Nutt., l. c.

Anantherix pumila Nutt., Trans. Am. Phil. Soc. II. 5 : 203. 1834.

Rather dry flat pine-barrens; rare. Collected once in COFFEE County, July 24, 1902. (*1442*). A single specimen seen about a month later in Camden County, near the coast. Elliott reported it also from Effingham County.

North Carolina to central Florida, in the pine-barrens.

APOCYNACEÆ.

TRACHELOSPERMUM Lemaire, Jard. Fleur. 1 : *pl. 61*. 1851.

T. difforme (Walt.) Gray, Syn. Fl. 2 : 85. 1878.

Only in swamps of streams rising north of our territory. Along the Ohoopee River in TATTNALL near Ohoopee, and the Ocmulgee in TELFAIR and COFFEE near Lumber City. Fl. June. Also seen along the Ogeechee River near Millen, a few miles outside of our limits, and to be expected farther down the same river.

Delaware to Florida (River Junction), West Tennessee, and Mexico, nearly confined to the coastal plain.

AMSONIA Walt., Fl. Car. 98. 1788.

A. rigida Shuttl.; Small, Fl. 935. 1903.

Shallow ponds. BERRIEN: Near Allapaha (also collected there by *Curtiss*); COLQUITT; Near Moultrie. Fl. May. More common in the Lower Oligocene region, particularly around mayhaw ponds.

Has been collected also in Florida.

A. ciliata Walt., l. c.

Dry pine-barrens; not common. MONTGOMERY, WILCOX, DOOLY. Fl. April–May. More frequent in the Lower Oligocene region.

North Carolina to Florida, Arkansas, and Texas, in the coastal plain.

A. tenuifolia Raf., New Fl. N. A. 4 : 58. 1836.

(?) *A. ciliata filifolia* Wood, Class-Book, 589. 1861.

Sand-hills and very dry pine-barrens, more rarely on rocks.

BULLOCH (*915*), EMANUEL, TATTNALL, MONTGOMERY, DODGE, TELFAIR, COFFEE. Fl. April–May. Extends inland to Laurens and Dooly Counties, and coastward to near Waycross.

Total range unknown. I do not regard this plant as specifically distinct from the preceding, but to treat it as a variety would necessitate an increase in the number of synonyms. (See Bull. Torrey Club **33**: 240, 241. 1906.)

MENYANTHACEÆ.

LIMNANTHEMUM S. G. Gmel., Nov. Act. Petrop. **14**: 527. *pl. 17. f. 2.* 1769.

L. aquaticum (Walt.) Britton, Trans. N. Y. Acad. Sci. **9**: 12. 1889.

L. trachyspermum (Mx.) Gray, Man. ed. 5.. 390. 1867.

Scarcely belongs to our flora. Grows in a pond at the extreme edge of the region, in WILCOX County near Queensland, and in ditches in MONTGOMERY and TATTNALL. Fl. summer.

Delaware to South Florida and Texas, in the coastal plain (but not reported from Alabama). Probably introduced in many places where it has been mistaken for a native (see Rhodora **7**: 78. 1905).

GENTIANACEÆ.

BARTONIA Muhl.; Willd., Neue Schrift. Ges. Nat. Fr. Berlin **3**: 444. 1801.

B. lanceolata Small, Fl. 932. 1903.

(?) *B. tenella brachiata* Wood, Class-Book 586. 1861. (See Bull. Torrey Club **33**: 240. 1906.)

Moist and intermediate pine-barrens; not abundant. APPLING, COFFEE, IRWIN, COLQUITT, THOMAS, DECATUR. Fl. July–Oct. Also in the Eocene and Lower Oligocene regions.

Range not fully worked out. Confined to the coastal plain, or nearly so.

SABBATIA Adans., Fam. **2**: 503. 1763.

S. gentianoides Ell., Sk. **1**: 286. 1817.

Moist pine-barrens at two or three places in COFFEE County; rare. Said to have been discovered in BULLOCH. Fl. July–Aug. Also occurs in Sumter, Lee, and Charlton Counties, but nowhere abundant.

Reported also from northeastern and northwestern Florida.

S. decandra (Walt.) Harper, Bull. Torrey Club 27 : 432. 1900.

In and around cypress ponds; not common. TATTNALL, COFFEE, IRWIN, BERRIEN, COLQUITT. Fl. July–Aug. Also in similar situations in Sumter, Ware, and Charlton Counties.

Known also from several stations in northern Florida.

S. foliosa Fernald, Bot. Gaz. 33 : 155. 1902.

(Including *S. Harperi* Small, Fl. 928. 1903.)

Chiefly in creek-swamps. BULLOCH (*964*), EMANUEL, TATTNALL, MONTGOMERY (*1866*), DODGE, TELFAIR, COFFEE, WILCOX, IRWIN, DOOLY, COLQUITT, THOMAS. Fl. June–Aug. Also in Johnson, Dodge, Early, and Decatur Counties in the Lower Oligocene region, and in Ware, Charlton, and Camden in the flat country. (For additional notes see Bull. Torrey Club 30 : 338, 339. 1903.)

South Carolina to Florida and Alabama, in the pine-barrens.

S. campanulata (L.) Torr., Fl. N. & Mid. U. S. 1 : 217. 1824.

S. gracilis (Mx.) Sal., Parad. Lond. *pl.* 32. 1806.

Moist pine-barrens, shallow (not cypress) ponds, and margins of creek-swamps. BULLOCH (*963*), EMANUEL, TATTNALL, MONTGOMERY, TELFAIR, COFFEE, WILCOX, BERRIEN, COLQUITT. Fl. June–Aug. Also in Sumter and Charlton Counties.

Massachusetts (?) to central Florida and Louisiana, mostly in the coastal plain. Also in the Bahamas (*Northrop*).

S. Elliottii Steud., Nomencl. ed. 2. 2 : 489. 1841.

"*S. paniculata* (Mx.) Pursh"; Ell., Sk. 1 : 282. 1817.

Normally in intermediate pine-barrens. APPLING, COFFEE (*681*), IRWIN, BERRIEN, COLQUITT. Fl. Sept.–Oct. Not known farther inland, but common in the flat country toward the coast.

Virginia (?) to central Florida, in the pine-barrens.

S. paniculata (Mx.) Pursh, Fl. 138. 1814.

Dry pine-barrens; rare. EMANUEL (*990*), TELFAIR, WILCOX. Fl. June–Aug. Also in Washington, Sumter, and Lee Counties in the Lower Oligocene region.

Virginia to Florida, in the pine-barrens.

S. lanceolata (Walt.) T. & G.; Gray, Man. 356. 1848.
S. corymbosa Baldw.; Ell., Sk. **1** : 283. 1817.
Moist pine-barrens. BULLOCH (*886*), TATTNALL, MONTGOMERY, TELFAIR, DODGE, COFFEE, WILCOX, IRWIN, BERRIEN, WORTH, COLQUITT. Fl. June–July. Also in Chatham and Bryan Counties, in the flat country.
New Jersey to central and northwestern Florida, in the pine-barrens.

S. macrophylla Hook., Comp. Bot. Mag. **1** : 171. 1835.
Moist pine-barrens, particularly near branch-swamps. EMANUEL, TELFAIR, COFFEE, WILCOX, IRWIN (*1415*), BERRIEN. Fl. July. Also near Americus. Sometimes difficult to distinguish from the preceding.
South to northern Florida, west to Louisiana, in the coastal plain.

LOGANIACEÆ.

GELSEMIUM Juss., Gen. 150. 1789.

G. sempervirens (L.) Ait. f., Hort. Kew. ed. 2. **2** : 64. 1811. YELLOW JESSAMINE.
Bluffs, hammocks, rock outcrops, etc. SCREVEN, EMANUEL, TATTNALL, MONTGOMERY, COFFEE, DOOLY. Fl. March. Frequent from Middle Georgia to the coast.
Widely distributed over the Southeastern United States except in the mountains.
Leaf-anatomy studied by Kearney, Contr. U. S. Nat. Herb. **5** : 505. 1901.

SPIGELIA L., Sp. Pl. 149. 1753.

S. Marilandica L., Syst. ed. 12. 734. 1767. (PINK-ROOT.)
Bluffs along the muddy rivers. MONTGOMERY: Stallings' Bluff; COFFEE: Barrow's Bluff; WILCOX: Upper Seven Bluffs (*2209*). Fl. May. More common farther inland, all the way to the mountains.
Widely distributed in the Eastern United States, but wanting over considerable areas.

CYNOCTONUM J. F. Gmel., Syst. **2** : 443. 1791.

C. Mitreola (L.) Britton, Mem. Torrey Club **5** : 258. 1894.
Mitreola petiolata (Walt.) T. & G.

BERRIEN: Low woods west of Tifton, where the Lafayette formation is presumably absent, Sept. 30, 1902. (See p. 111.) In Sumter County I have seen it in a very similar place, with some of the same associates.

Virginia to South Florida, Tennessee, and Mexico, mostly in the coastal plain. Also in the West Indies and South America.

C. **sessilifolium** (Walt.) Gmel., l. c.

COFFEE: Seen only once in moist pine-barrens, Douglas, July 21, 1902. Grows also in Pike (see Bull. Torrey Club **30**: 294), Sumter, and Charlton Counties.

North Carolina to central Florida and Louisiana, in the coastal plain, with the above-mentioned exception.

POLYPREMUM L., Sp. Pl. 111. 1753.

P. PROCUMBENS L., l. c.

A weed in dry or damp sandy soil. TATTNALL: Collins; COFFEE: Douglas. More common in older settled regions, from Middle Georgia to the coast. Fl. all summer.

Pennsylvania to South Florida and Texas. Also in the West Indies and Mexico, where it is perhaps native.

OLEACEÆ.

OSMANTHUS Lour., Fl. Cochin. *pl. 28.* 1790.

O. **Americanus** (L.) Gray, Syn. Fl. **2**: 78. 1878. (DEVIL WOOD.)

One of the most characteristic small trees of hammocks. Also occasionally on bluffs or in non-alluvial swamps. Sometimes nearly a foot in diameter and 30 feet tall. EMANUEL, TATTNALL, MONTGOMERY, DODGE, TELFAIR, COFFEE, WILCOX, BERRIEN, COLQUITT. Ranges inland to Stewart County and coastward to the islands. In the Eocene region (particularly in Randolph County) its usual habitat is shady ravines.

North Carolina to Florida and Louisiana, strictly confined to the coastal plain.

CHIONANTHUS L., Sp. Pl. 8. 1753.

C. **Virginica** L., l. c. GRAYBEARD.

On bluffs along the large rivers in MONTGOMERY and WILCOX.

Also in woods where the Lafayette formation is supposed to be absent in BERRIEN a few miles west of Tifton, and around the Rock House in DOOLY. More common farther inland, flowering in April and May in Middle Georgia.

Widely distributed in the Eastern United States south of the glaciated region.

Leaf-anatomy studied by Kearney, Contr. U. S. Nat. Herb. **5**: 504–505. 1901.

ADELIA P. Br. Hist. Jam. 361. 1756.

A. acuminata Mx., Fl. **2**: 225. *pl. 48.* 1803.

Swamps of the muddy rivers. Noted along the Ogeechee near Rocky Ford, the Oconee near Mount Vernon, and the Ocmulgee near Lumber City. A large shrub, but scarcely arborescent. Extends up the Savannah and Flint Rivers to the fall-line; coastward limit not known.

South Carolina to Tennessee, Illinois, Missouri, and Texas, in the coastal plain.

FRAXINUS L., Sp. Pl. 1057. 1753. "ASH."

F. Caroliniana Mill., Gard. Dict. ed. 8. 1768. (No. 6).

Swamps of all our creeks and rivers, muddy or otherwise; common. A small tree or oftener a shrub. Pretty widely distributed over South Georgia.

Virginia to Florida, Arkansas, and Texas, in the coastal plain.

STYRACACEÆ.

STYRAX L. Sp. Pl. 444. 1753.

S. grandifolia Ait., Hort. Kew. **2**: 75. 1789.

Sandy banks of rivers, etc. TATTNALL (*2154*), COFFEE (*1992*), BERRIEN. Fl. April–May. Extends inland to the fall-line sand-hills in Richmond County (*A. Cuthbert*). Also in the vicinity of Thomasville (*Mrs. Taylor*).

Southeastern Virginia to northeastern Florida and Louisiana, in the coastal plain.

Leaf-anatomy described by Kearney, Contr. U. S. Nat. Herb. **5**: 504. 1901.

S. pulverulenta Mx., Fl. **2**: 41. 1803.

Wet pine-barrens; not common. BULLOCH: near Bloys (*901*)

and Statesboro; IRWIN: near Fitzgerald. Fl. April.

Virginia to Florida, Arkansas, and Texas, in the coastal plain.

MOHRODENDRON Britton, Gard. & For. **6**:463. 1893.

M. dipterum (L.) Britton, l. c.

In hammocks; rather rare. COFFEE, BERRIEN. More common in the upper third of the coastal plain, on sandy river-banks, extending inland to Stewart County at least. Fl. spring. A small tree.

South Carolina to West Florida and Louisiana, in the coastal plain.

SYMPLOCACEÆ.

SYMPLOCOS L., Sp. Pl. ed. 2. 747. 1763.

S. tinctoria (L.) L'Her., Trans. Linn. Soc. **1**:176. 1791.

Hammocks, bluffs, and rock outcrops. EMANUEL, TATTNALL, MONTGOMERY, DOOLY, BERRIEN. Fl. March–April. Only a shrub in our territory. Ranges nearly all over Georgia, but can hardly be called common.

Widely distributed over the Eastern United States between latitudes 30° and 39°.

Leaf-anatomy described by Kearney, Contr. U. S. Nat. Herb. **5**:503–504. 1901.

SAPOTACEÆ.

BUMELIA Sw., Prodr. 49. 1788.

B. lanuginosa (Mx.) Pers., Syn. **1**:237. 1805.

COFFEE: Sand-hills of Seventeen Mile Creek; WILCOX: Hammock of House Creek. Pretty well distributed over South Georgia, but not common.

South to South Florida, and west to Missouri, Kansas, and Texas, mostly in the coastal plain.

B. reclinata Vent., Choix. 22. 1893.

B. lycioides reclinata Gray, Syn. Fl. **2**:68. 1878.

TATTNALL: Sand-hills of Ohoopee River (*1851*) and Rocky Creek; MONTGOMERY: Very dry pine-barrens on both sides of the Oconee River near Mount Vernon and Ochwalkee. Fl. spring.

Reported also from Florida and Louisiana (but not Alabama).

EBENACEÆ.

DIOSPYROS L., Sp. Pl. 1057. 1753.

D. Virginiana L., l. c. "PERSIMMON."

Usually in dry pine-barrens, but also in swamps and shallow (not cypress) ponds and on sand-hills. SCREVEN, TATTNALL, MONTGOMERY, TELFAIR, COFFEE, IRWIN, BERRIEN. Fl. spring. Never very large in our territory, and in dry pine-barrens usually only a shrub. (Perhaps does not fruit in that condition.) Common nearly all over Georgia. This has perhaps the greatest adaptability to different habitats of any North American tree. It seems equally at home in the maritime counties and in the mountains, in ponds and lime-sinks and on sand-hills, in old fields and in creek-bottoms. It is liable to turn up almost anywhere within its climatic limits, perhaps on account of the readiness with which its seeds are transported by small quadrupeds.

Ranges nearly throughout the Eastern United States south of latitude 41°.

VACCINIACEÆ.

VACCINIUM L., Sp. Pl. 349. 1753.

V. nitidum Andr., Bot. Rep. **7**: pl. 480. 1807. "GOPHER BERRY." (Perhaps including *V. Myrsinites* Lam.)

Dry and intermediate pine-barrens and low places in sand-hills. BULLOCH, TELFAIR, APPLING, COFFEE, BERRIEN, THOMAS. Fl. spring. Common in the flat pine-barrens toward the coast. Evergreen.

South to central Florida.

V. spp.

One or two larger species (deciduous) grow in sandy places along the Ohoopee River in Tattnall County. One was observed with ripe fruit June 26, 1903, and another in the same condition April 26, 1904.

BATODENDRON Nutt., Trans. Am. Phil. Soc. II. **8**: 261. 1843.

B. arboreum (Marsh) Nutt., l. c. "SPARKLEBERRY."

Hammocks, sand-hills, and bluffs; common. Often associated

with *Osmanthus*. Fl. May. A large shrub, often tree-like. Pretty well distributed over the state, with considerable variation in habitat. In Middle Georgia it grows both on sandy river-banks and rocky mountain-summits.

Widely distributed in the Southeastern United States.

Leaf-anatomy studied by Kearney, Contr. U. S. Nat. Herb. **5**: 502–503. 1901.

POLYCODIUM Raf., Am. Month. Mag. **2**: 266. 1818.

P. cæsium Greene, Pittonia **3**: 325. 1898. "GOOSEBERRY."

Sand-hills and dry pine-barrens; common. Fl. April. A low shrub, rarely over two feet tall. Pretty widely distributed in the pine-barrens of Georgia, also in South Carolina and Florida.

P. revolutum Greene, l. c.

BERRIEN: Sand-hills of Allapaha River, May 5, 1904, in flower (*2191*). A large shrub, six feet tall.

Known otherwise only from the type-locality in Lake County, Florida.

GAYLUSSACIA HBK., Nov. Gen. **3**: 275. 1818.

G. frondosa (L.) T. & G.; Torr., Fl. N. Y. **1**: 449. 1843. "HUCKLEBERRY."

From intermediate pine-barrens to non-alluvial swamps; common and variable. Fl. April. In the pine-barrens it is often only about a foot tall, and is then var. *nana* Gray (represented by no. *2094* from EMANUEL Co.). In sand-hill bogs the leaves are apt to be more or less pubescent and it is then var. *tomentosa* Gray (no. *820* from EMANUEL Co.). The largest forms grow in the swamps. It is almost impossible to decide where to draw the lines between the different forms. This is one of the best edible berries in our territory.

Pretty widely distributed in the Eastern United States, in one form or another, but in Georgia apparently confined to the coastal plain.

G. dumosa (Andr.) T. & G.; Gray, Man. 259. 1848.

Sand-hills, dry and intermediate pine-barrens, or rarely on

rock outcrops; common. Fl. April. Pretty widely distributed in South Georgia, and on the sunny slopes of some of the mountains in the northern part of the state (see Small, Bull. Torrey Club **21** : 18–19. 1894).

Newfoundland to Louisiana, rarely more than 300 miles from the coast (see Rhodora, **7** : 75. 1905).

ERICACEÆ.

CHOLISMA Raf., Am. Month. Mag. **4** : 193. 1819.

(Original spelling XOLISMA. See Greene, Torreya **4** : 173–174. 1904.)

C. ligustrina (L.) Britton, Mem. Torrey Club **4** : 134. 1894.

COLQUITT: Swamp of Ochlocknee Creek near Moultrie (*1673*). More common farther inland, for instance in Middle Georgia, where it flowers in May and June.

Widely distributed in the Eastern United States.

What appears to be a dwarf form of this, a knee-high shrub, grows in wet pine-barrens in BULLOCH (*888*), TATTNALL, COFFEE, IRWIN, and Camden Counties.

C. ferruginea (Walt.) Heller, Cat. 6. 1898.

The typical form (a small tree or large shrub, sometimes twenty feet tall) grows in hammocks and on sand-hill bluffs in COFFEE (*2047*) and BERRIEN Counties, flowering in May. The var. *fruticosa*, scarcely differing except in size, is common in intermediate flat pine-barrens in APPLING, TELFAIR, COFFEE (*682*), IRWIN, BERRIEN, and COLQUITT, and still more so in the flat country toward the coast. There seem to be all gradations between the two extremes.

South Carolina to central Florida, in the lower half of the coastal plain.

PIERIS D. Don, Edinb. New Phil. Jour. **17** : 159. 1834.

P. Mariana (L.) B. & H.

Sand-hills, dry and intermediate pine-barrens, particularly the last named. BULLOCH (*867*), EMANUEL, TATTNALL, MONTGOMERY, COFFEE, WILCOX, IRWIN, BERRIEN, THOMAS. Fl. April–May. Less common in other parts of the coastal plain.

Rhode Island to Florida, in the coastal plain. Also reported from Tennessee and Arkansas, but not Alabama.

P. nitida (Bartr.) BH.

Moist pine-barrens, swamps (not muddy), ponds and hammocks; common. Fl. March-April. Throughout the pine-barren region of Georgia, and known from several places in the upper fourth of the coastal plain, where the Columbia sand is present.

Virginia to central Florida and Louisiana, in the coastal plain. Leaf-anatomy discussed by Kearney, Contr. U. S. Nat. Herb. **5** : 500–501. 1901.

P. phillyreifolia (Hook.) DC., Prodr. **7** : 599. 1839.

Figured in Hook. Ic. Plant. **2**: 122. 1837; Lindl. Bot. Reg. **30**: *pl. 36.* 1844.

BERRIEN: On *Taxodium imbricarium* in ponds and moist pine-barrens between Sparks and Adel, May 7, 1904. More frequent in the flat country, in Charlton, Lowndes, and Brooks Counties, especially Lowndes, where it flowers in February.

Also occurs in West Florida and Mobile County, Alabama. For a description of some of the unique features of this plant see Torreya **2** : 21–22. 1903.

LEUCOTHOË D. Don., Edinb. New Phil. Jour. **17** : 159. 1834.

L. racemosa (L.) Gray, Man. ed. 2. 252. 1856.

Mostly in and around creek-swamps; not common. EMANUEL, TATTNALL, COLQUITT (*1672*). Fl. spring.

Massachusetts to Florida, Missouri, and Louisiana, mostly in the coastal plain.

Leaf-anatomy studied by Kearney, Contr. U. S. Nat. Herb. **5** : 500. 1901.

L. elongata Small, Bull. N. Y. Bot. Gard. **1** : 284. 1899.

In and around sand-hill ponds. MONTGOMERY, BERRIEN. Very similar to the preceding, and perhaps only a xerophytic modification of it.

Virginia to Florida, in the coastal plain.

L. axillaris (Lam.) Don, l. c.

Non-alluvial creek-swamps; not common. COFFEE, BERRIEN,

COLQUITT. Fl. April–June.

Virginia to northeastern Florida and Mississippi, in the coastal plain. Difficult to distinguish from *L. Catesbæi* (Walt.) Gray, which ranges from Virginia to Georgia in the mountains and Piedmont region.

Leaf-anatomy studied by Kearney, Contr. U. S. Nat. Herb. **5** : 499–500. *f. 89.* 1901.

L. platyphylla Small, Bull. Torrey Club, **28** : 290. 1901.

EMANUEL: Edge of non-alluvial swamp at base of hammock of Little Ohoopee River, April 5, 1904 (*2093*). Not observed elsewhere. Seems to differ from the preceding only in having slightly broader leaves.

Georgia and Mississippi, in the coastal plain.

KALMIA L., Sp. Pl. 391. 1753.

K. hirsuta Walt., Fl. Car. 138. 1788.

Intermediate and moist pine-barrens, and corresponding places on sand-hills; frequent. BULLOCH (*961*), EMANUEL, MONTGOMERY, DODGE, TELFAIR, APPLING, COFFEE (*687*), IRWIN, BERRIEN, COLQUITT, THOMAS. Fl. June–Sept. Not known farther inland, but quite common in the flat pine-barrens.

North Carolina to northern Florida and Mississippi, in the pine-barrens.

AZALEA L., Sp. Pl. 150. 1753. "HONEYSUCKLE."

A. viscosa L., Sp. Pl. 151. 1753.

Moist pine-barrens, particularly towards the edges of swamps. EMANUEL, MONTGOMERY, WILCOX, IRWIN, COLQUITT, DECATUR (*1929*.) Fl. May–July. Widely distributed over South Georgia, but not known in the other parts of the state.

New England west to Ohio and south to Florida, Arkansas, and Texas, mostly in the glaciated region and coastal plain.

A. nudiflora L., Sp. Pl. ed. 2. 214. 1762.

Intermediate and moist pine-barrens and edges of swamps. In pine-barrens often only knee-high. Common in SCREVEN, BULLOCH, and EMANUEL, flowering in March and April.

Perhaps overlooked elsewhere in the region for lack of flowers. Common in rich woods farther inland, all the way to the mountains. In Georgia I have seen only the ordinary pink-flowered form.

Widely distributed in the Eastern United States between latitudes 30° and 43°.

A. candida Small, Bull. Torrey Club **28** : 360. 1901.

On or near Altamaha Grit outcrops, especially on banks of creeks and rivers. TATTNALL (*1858*), COFFEE, BERRIEN. Flowers before the middle of April. (See Bull. Torrey Club **32** : 166. 1905.) Known otherwise only from the type-locality in Lowndes County, just south of our territory, and perhaps from neighboring parts of Florida.

ELLIOTTIA Muhl.; Ell., Sk. **1** : 448. 1817.

E. racemosa Muhl., l. c.

(PLATES XIX (FIG. 2) AND XX.)

Oak ridges and bases of sand-hills; rare. BULLOCH (*962*), TELFAIR (*1873*), COFFEE (*2011*). Said to occur also in SCREVEN and EMANUEL, probably within our territory (see Plant World **6** : 60. 1903). Fl. June–July.

Confined to the coastal plain of Georgia and adjacent parts of South Carolina. Formerly known from Burke, Richmond, and Columbia (?) Counties, and Aiken Co., S. C., but it has not been seen in the wild state outside of the Altamaha Grit region for nearly thirty years. (See Jour. N. Y. Bot. Gard. **2** : 113, 114. Aug. 1901. Am. Gardening **22** : 631. Sept. 14, 1901; Plant World, **5** : 87–90. *pl. 12*. 1902; Sarg., Silva N. A. **14** : 31. *pl. 712*. 1902. Torreya **3** : 106. 1903; Bull. Torrey Club **32** ; 165–166. 1905.)

PYROLACEÆ.

CHIMAPHILA Pursh, Fl. 299. 1814.

C. maculata (L.) Pursh, Fl. 300. 1814. (PIPSISSEWA.).

BERRIEN: Rich woods near Little River, southwest of Tifton, Sept. 29, 1902. (See page 112 of this volume, also Bull. Torrey Club **31** : 24. 1904.) Frequent in Middle Georgia, where it flowers in June.

Ranges northward to Canada.

CLETHRACEÆ.

CLETHRA L., Sp. Pl. 396. 1753.

C. alnifolia L., l. c.

Moist pine-barrens, branch- and creek-swamps, etc.; quite common. Fl. July–Aug. Pretty widely distributed over South Georgia, but not known in other parts of the state.

Maine to northern Florida and Louisiana, in the glaciated region and coastal plain. (See Rhodora **7** : 75. 1905.)

UMBELLIFERÆ.

DAUCUS L., Sp. Pl. 242. 1753. (CARROT.)

D. PUSILLUS Mx., Fl. **1** : 164. 1803.

Streets of Fitzgerald, May 17, 1904. More common in older towns farther inland, at least as far as Athens.

South Carolina to Middle Florida, British Columbia (?), and Mexico. Natural range and habitat uncertain. Certainly not native in Georgia.

OXYPOLIS Raf., Neog. 2. 1825.

O. rigidior (L.) C. & R. Contr. U. S. Nat. Herb. **7** : 194. 1900.

Branch-swamps and wet woods; rare. COFFEE (*722*), BERRIEN. Also in Middle Georgia, where it flowers September to November.

Widely distributed in the Eastern United States, but rare in the coastal plain.

O. ternata (Nutt.) Heller, Cat. 5. 1898.

Moist pine-barrens; inconspicuous and probably rare. IRWIN, BERRIEN (*666*), WORTH, COLQUITT. Flowers probably in November. Not seen elsewhere.

North Carolina to West Florida, in the pine-barrens.

O. filiformis (Walt.) Britton, Mem. Torr. Club **5** : 239. 1894.

Moist pine-barrens. Frequent throughout our territory and in all the rest of the pine-barrens of Georgia (but only on the Columbia formation. See Science II. **16** : 69. 1902). Fl. July–Aug.

Virginia to central Florida and Louisiana, in the pine-barrens.

Anatomy discussed by Rennert, Bull. Torrey Club **30** : 403–411. *f. 1–3.* 1903.

ANGELICA L., Sp. Pl. 250. 1753.

A. dentata (Chapm.) C. & R., Bot. Gaz. **12** : 61. 1887.

Dry pine-barrens and sand-hills, in the southwestern half of our territory. IRWIN, BERRIEN, COLQUITT (*1654*). Fl. Sept.–Oct.

Known otherwise only from Gadsden and Franklin Counties, Middle Florida.

THASPIUM Nutt., Gen. **1** : 196. 1818.

T. trifoliatum aureum (Nutt.) Britton, Mem. Torrey Club **5** : 240. 1894.

DOOLY: Around lime-sink east of Wenona, Sept. 1, 1903. Does not properly belong to this flora, but ranges farther inland, all the way to the mountains. Fl. spring.

Widely distributed in the Eastern United States.

ZIZIA Koch, Nov. Act. Cæs. Leop. Acad. **12** : 128. 1824.

Z. Bebbii [C. & R.] Britton, Mem. Torrey Club **2** : 35. 1890.

On river-bluffs; rare, and not characteristic of our flora. MONTGOMERY: Near Ochwalkee; WILCOX: Upper Seven Bluffs. Fl. spring.

Ranges northward, mostly in the mountains, to West Virginia.

Z. arenicola Rose, Proc. U. S. Nat. Mus. **29** : 442. 1905.

COLQUITT: Base of sand-hills of Ochlocknee Creek near Moultrie, Aug. 22, 1903. (no. *1940*, type). Also in somewhat similar situations in Sumter County.

Not known elsewhere.

SPERMOLEPIS Raf. Neog. 2. 1825.

S. DIVARICATUS (Walt.) Britton, Torrey Club **5** : 244. 1894.

A weed in dry sandy soil. BULLOCH: near Bloys: EMANUEL: Swainsboro; BERRIEN: Nashville and vicinity. Fl. spring. Common around Millen, a little farther inland.

North Carolina to Florida, Kansas, and Texas. (See remarks under *Isopappus divaricatus*, p. 146). Natural range and habitat uncertain.

ERYNGIUM L., Sp. Pl. 232. 1753.

E. yuccifolium Mx., Fl. **1** : 164. 1803.

E. aquaticum L., in part.

BULLOCH: Moist pine-barrens near Bloys, June, 1901. TATTNALL: Rock outcrop near Pendleton Creek, June 26, 1903. Fl. June. More common farther inland, usually in dry soil, but habitat not well understood.

Widely distributed in the Eastern United States south of latitude 41°, but probably not everywhere indigenous.

E. synchætum [Gray] C. &. R., Contr. U. S. Nat. Herb. **7**: 44. 1900.

Normally in intermediate pine-barrens. EMANUEL, MONTGOMERY, DODGE, TELFAIR, COFFEE, IRWIN, WILCOX, DOOLY. Fl. summer. Extends inland to Johnson, Sumter, and Calhoun Counties and coastward to Camden.

South to Florida, west to Arkansas (?) and Texas, in the pine-barrens.

E. virgatum Lam., Encyc. **4**: 757. 1796.

? *E. integrifolium* Walt., Fl. Car. 112. 1788.

Moist pine-barrens; seen only in the southern part of our territory. COLQUITT, THOMAS (*1181*), DECATUR. Fl. Aug.–Sept. Also in several counties nearer the coast, and at a few places in Middle Georgia (see Bull. Torrey Club **30**: 294. 1903).

Western North Carolina to northern Florida and Texas.

E. Ludovicianum Morong, Bull. Torrey Club **14**: 51. 1887.

Moist pine-barrens. DODGE, WILCOX, COFFEE (*709*), IRWIN, BERRIEN, DOOLY, WORTH, COLQUITT. (*1664*). Fl. July–Oct. Extends inland to Jefferson (*M. H. Hopkins*) and Sumter Counties, and coastward to Charlton. Close to the preceding but easily distinguished in the field (see Bull. Torrey Club **28**: 477. 1901; **31**: 23. 1904).

Known also in the coastal plain of Louisiana and Texas.

E. Virginianum Lam., Encyc. **4**: 759. 1796.

? *E. aquaticum* L., Sp. Pl. 232. 1753. (in part).

BERRIEN: Low grounds where the Lafayette formation is absent, west and southwest of Tifton, September, 1902 (*1690*). Also occurs in very similar surroundings in Sumter and Lee Counties (see remarks under *Cynoctonum Mitreola*, p. 179).

New Jersey to Florida and Texas (?) (but not reported from Alabama), in the coastal plain. It should perhaps also turn up in the West Indies, like several of its associates.

SANICULA L., Sp. Pl. 235. 1753.

S. Marilandica L., l. c.

MONTGOMERY: Bluff along Oconee River near Ochwalkee, July 1, 1903. More common farther inland.

Widely distributed in North America north of latitude 32°.

CENTELLA L., Pl. Rar. Afr. 28. 1760.

GLYCERIA Nutt., Gen. 1: 177. 1818. Not R. Br. (Changed to *Chondrocarpus* in errata.)

C. repanda (Pers.) Small, Fl. 859. 1903.

Hydrocotyle reniformis Walt., Fl. Car. 113. 1753.

Moist pine-barrens, shallow ponds, etc. Quite common in our territory and throughout the pine-barrens of Georgia. Fl. July-Aug.

Maryland to South Florida and Texas, in the coastal plain. Said to have a wide distribution in the tropics, but this deserves investigation.

ARALIACEÆ.

ARALIA L., Sp. Pl. 273. 1753.

A. spinosa L., l. c. PRICKLY ASH.

Bluffs and hammock-like places along rivers, but apparently never in genuine hammocks. SCREVEN, BULLOCH, TATTNALL, MONTGOMERY, TELFAIR, COFFEE, BERRIEN. Fl. August. Widely distributed over the state in shady places, from the mountains of Northwest Georgia nearly to the coast.

Nearly throughout the Eastern United States south of the glaciated region.

CORNACEÆ.

CORNUS L., Sp. Pl. 117. 1753.

C. florida L., l. c. "DOGWOOD."

A characteristic inhabitant of hammocks, occurring also on bluffs, and in rich woods along the Altamaha Grit escarp-

ment (presumably on the Chattahoochee formation). In regular hammocks it grows in EMANUEL, DODGE, COFFEE, WILCOX, and doubtless other counties, and along the escarpment it has been noted in SCREVEN, BULLOCH, EMANUEL, WILCOX, WORTH, and DECATUR. Fl. March–April. Outside of our territory it probably grows in every county in Georgia.

Ranges nearly throughout the Eastern United States south of latitude 43°.

NYSSA L., Sp. Pl. 1058. 1753.

N. Ogeche Marsh., Arb. Am. 97. 1785. "TUPELO GUM." OGEECHEE LIME.

Common nearly throughout (not yet noted in Screven, Bulloch, Emanuel, Dodge, and Decatur), in streams of all sizes, and rarely in ponds. Fl. April–May. Extends coastward to within about 20 miles of the ocean, but in the other direction it seems to stop abruptly at the Altamaha Grit escarpment, particularly in Dooly and Worth Counties. (See Bull. Torrey Club **32**: 147. 1905.) A large shrub or small tree, quite different in aspect from its congeners. Fruit very acid, used to some extent for preserves.

Ranges from extreme southern South Carolina to the vicinity of Apalachicola, Florida. Like *Pinckneya pubens*, which has a very similar range, it is probably more abundant in our territory than in all the rest of its range combined.

N. uniflora Wang., Am. Holz. 83. *pl.* 27. *f.* 57. 1787.

N. aquatica L., Sp. Pl. 1058, in part.

Only in swamps of streams rising north of our territory. SCREVEN and BULLOCH: Ogeechee River; EMANUEL: Little Ohoopee River; TATTNALL: Ohoopee River; MONTGOMERY: Oconee River near Mount Vernon; MONTGOMERY and TELFAIR: Gum Swamp Creek near McRae; TELFAIR: Ocmulgee River. Fl. April. Extends down the Altamaha River to within about 20 miles of the coast. Pretty widely scattered in South Georgia, in similar situations, and known from a few places above the fall-line near the western border of the state. (See Bull. Torrey Club **30**: 294. 1903.)

Virginia to Florida, Illinois, and Texas, mostly confined to the coastal plain.

Leaf-anatomy discussed by Kearney, Contr. U. S. Nat. Herb. **5**: 498–499. 1901.

N. biflora Walt., Fl. Car. 253. 1788. "BLACK GUM."

Common in ponds, branches, creeks, and small rivers, probably on every square mile of our territory.

Grows nearly all over South Georgia. Farther inland mostly replaced by *N. sylvatica* Marsh., with which it perhaps intergrades. (No distinction is made between them by the natives.)

New Jersey to Florida and Texas, mostly in the coastal plain.

HALORAGIDACEÆ.

PROSPERPINACA L., Sp. Pl. 88. 1753.

P. palustris L., l. c.

Branch-swamps, etc.; not common. EMANUEL, MONTGOMERY, COLQUITT. Fl. summer.

Widely distributed in the Eastern United States and southward.

P. pectinata Lam., Tab. **1**: 214. *pl. 50. f. 1.* 1791.

Branch-swamps and shallow ponds. BULLOCH (*844*), EMANUEL, TATTNALL, COFFEE, IRWIN. Fl. May–Aug. Also in Sumter County, in the Lower Oligocene region.

Massachusetts to central Florida and Texas, in the coastal plain.

A form apparently intermediate between these two species grows in moist pine-barrens and branch-swamps in BULLOCH, COFFEE (*1427*), IRWIN (*2210*), and BERRIEN. See Bull. Torrey Club. **33**: 238–239. 1906.

MYRIOPHYLLUM L., Sp. Pl. 992. 1753.

M. heterophyllum Mx., Fl. **2**: 191. 1803.

Seen only in permanent ponds along the inland edge of our territory, in SCREVEN (*2084*) and WILCOX. Fl. spring and summer. More frequent in sluggish streams in the upper third of the coastal plain.

Range not well worked out, no doubt partly because of the difficulty of accurately determining the species.

ONAGRACEÆ.

KNEIFFIA Spach, Hist. Veg. **4**: 373. 1835.

K. linearis (Mx.) Spach, Hist. Veg. **4**: 376. 1835.

Dry pine-barrens. BULLOCH (*2164*), TATTNALL, MONTGOMERY, COFFEE, WILCOX, IRWIN, BERRIEN. Fl. April–May. Also at least as far inland as the pine-barrens of Sumter County.

Including *K. arenicola*, *subglobosa*, and *longipedicellata*, which I am unable to distinguish, this ranges from Connecticut (?) to Florida and Arkansas, mostly in the coastal plain.

RAIMANNIA Rose, Contr. U. S. Nat. Herb. **8**: 330. 1905.

R. LACINIATA (Hill) Rose, l. c.

Œnothera sinuata L., Mant. **2**: 228. 1771.

Fields, roadsides, etc. EMANUEL: Near Swainsboro; IRWIN: Fitzgerald; BERRIEN: near Nashville. Flowers mostly in spring. More common in Middle Georgia.

Widely distributed in the Eastern United States and Mexico, but certainly not native eastward.

GAURA L., Sp. Pl. 347. 1753.

G. Michauxii Spach, Nouv. Ann. Mus. Paris, **4**: 379. 1835.

Dry pine-barrens and sand-hills. DODGE, IRWIN, BERRIEN, COLQUITT. Fl. July–Oct. Extends inland to Middle Georgia, but only as a weed in many places.

Widely distributed in the Eastern United States south of latitude 38°.

LUDWIGIA L., Sp. Pl. 118. 1753.

L. alternifolia L., l. c.

COFFEE: Ocmulgee River swamp opposite Lumber City, Sept. 11, 1903. IRWIN: a weed near Cycloneta, Oct. 2, 1902. Fl. all summer. More common farther inland, in Middle and Southwest Georgia, but usually a weed in ditches. Probably native in some places where the Lafayette formation is absent.

Widely distributed in the Eastern United States, but natural range and habitat uncertain.

L. hirtella Raf., Med. Rep. II. **5**: 358. 1808.

Moist pine-barrens; not abundant. DODGE, COFFEE, IRWIN,

BERRIEN, DOOLY, COLQUITT. Fl. June–Aug. Inland to Laurens, Sumter, and Early Counties in the Lower Oligocene region, and coastward to Camden.

New Jersey to West Florida, Arkansas, and Texas, mostly in the pine-barrens.

L. **virgata** Mx., Fl. **1**: 89. 1803; Harper, Torreya **4**: 162. *f. 1.* 1904.

Rather dry pine-barrens; not common. TATTNALL (*999*), MONTGOMERY, IRWIN. Fl. June–Sept. Also inland to Sumter County and coastward to Chatham and Charlton.

North Carolina to Florida and Alabama (?), in the pine-barrens.

L. **linearis** Walt., Fl. Car. 80. 1788.

Moist pine-barrens; apparently rare. COFFEE (*720*), DOOLY. Fl. Aug.–Sept. Also in some other parts of the pine-barrens of Georgia, where it is inclined, like several of its congeners, to become a weed in moist sandy ditches along railroads.

New Jersey to northern Florida and Louisiana, in the coastal plain.

L. **linifolia** Poir., Suppl. **3**: 513. 1813.

Shallow ponds. BERRIEN, COLQUITT. Fl. July–Sept. More common in the Lower Oligocene region, but occurs also in Charlton County, in the flat country.

North Carolina to central Florida and Alabama, in the pine-barrens.

L. **sphærocarpa** Ell., Sk. **1**: 213. 1817.

WILCOX: Small permanent pond near Queensland, just on the edge of our territory, May 17, 1904. Belongs more properly to the adjacent Lower Oligocene region, where it is frequent.

Massachusetts to West Florida, in the coastal plain.

L. **pilosa** Walt., Fl. Car. 89. 1788.

Common throughout the whole pine-barren region of Georgia, in and near branch-swamps, shallow ponds, etc. Fl. all summer.

North Carolina to Florida and Louisiana, in the coastal plain.

L. **suffruticosa** Walt., Fl. Car. 90. 1788.

L. capitata Mx., Fl. **1**: 90. 1803.

COFFEE: Margin of sand-hill pond near Chatterton, July 29,

1902. Known also from Sumter, Lee, Bryan, Charlton, Clinch, and Lowndes Counties, mostly around ponds.

North Carolina to South Florida, in the pine-barrens.

L. glandulosa Walt., Fl. Car. 88. 1788.

COFFEE: Ocmulgee River swamp opposite Lumber City, Sept. 11, 1903. Also in Americus, along Muckalee Creek.

South Carolina to Illinois and Texas, sometimes a weed.

L. microcarpa Mx., Fl. 1 : 88. 1803.

BERRIEN: In places where the Lafayette formation is apparently absent, west and southwest of Tifton, September 1902. (See pp. 110–112). Also in Johnson, Dooly, Sumter, Lee, Dougherty, and Early Counties in the Lower Oligocene region, apparently always in the same relation to the Lafayette formation.

North Carolina to South Florida and Mississippi (?) (but not reported from Alabama), in the coastal plain. Also in the Bahamas (*Britton*.)

ISNARDIA L., Sp. Pl. 120. 1753.

I. palustris L., l. c.

Shallow ponds, BULLOCH and BERRIEN. Widely distributed over the state, commonly a weed in ditches. Fl. all summer.

Cosmopolitan, but natural range uncertain.

MELASTOMACEÆ.

RHEXIA L., Sp. Pl. 346. 1753.

R. Alifanus Walt., Fl. Car. 130. 1788.

R. glabella Mx., Fl. 1 : 222. 1803. (See Bull. Torrey Club **33** : 238. 1906.)

Moist or intermediate pine-barrens; common throughout the pine-barren region of Georgia. Fl. June–Aug. The handsomest species of the genus.

North Carolina to northern Florida and Louisiana, in the coastal plain, nearly confined to the pine-barrens.

R. stricta Pursh, Fl. 258. 1814.

Moist pine-barrens and ponds. APPLING, COFFEE (*715*), IRWIN, DOOLY, and doubtless elsewhere. (In 1901 and 1902 I noted what I took to be *R. Virginica* at many other stations in

this region, and coastward, but it is probably all *R. stricta*. This cannot be verified, however, without going over the same ground again). Fl. summer.

"South Carolina to Florida and Louisiana" (*Mohr*). "Georgia and Florida" (*Small*). At any rate confined to the pine-barrens.

R. filiformis Small, Bull. Torrey Club **25** : 468. 1898.

Chiefly in rather dry pine-barrens and in corresponding places on sand-hills. BULLOCH, TATTNALL, MONTGOMERY, DODGE, COFFEE, WILCOX. Fl. all summer. Scattered over the whole pine-barren region of Georgia.

Reported only from Georgia and Florida, but doubtless has a wider range.

R. Mariana L., Sp. Pl. 346. 1753.

COFFEE: Moist pine-barrens and margins of ponds, along Seventeen Mile Creek north and east of Douglas, July, 1902. In the vicinity of Americus it flowers June–September.

Long Island to Florida, Missouri, and Texas, mostly in the coastal plain.

R. ciliosa Mx., Fl. **1** : 221. 1803.

Moist pine-barrens and sand-hill bogs. DODGE, APPLING, COFFEE, WILCOX, IRWIN, COLQUITT, THOMAS (*1175*), DECATUR. Fl. June–Sept. Occurs nearly throughout the pine-barrens of Georgia, also in Pike County, Middle Georgia (Bull. Torrey Club **30** : 294. 1903).

Maryland to central Florida and Louisiana, mostly in the pine-barrens.

R. lutea Walt., Fl. Car. 130. 1788.

Moist pine-barrens. BULLOCH (*890*), EMANUEL, TATTNALL, DODGE, COFFEE (*712*), WILCOX, IRWIN, BERRIEN, COLQUITT. Fl. June–July. Also coastward, but rarely farther inland.

North Carolina to northern Florida and Louisiana, in the pine-barrens.

LAURACEÆ.

BENZOIN Fabr., Enum. Pl. Hort. Helmst. ed. 2, 401. 1763.

B. melissæfolium (Walt.) Nees, Syst. 494. 1836.

MONTGOMERY: Margin of pond in sand-hills of Little Ocmulgee River opposite Lumber City, Sept. 10, 1903 (*1989*). Not seen elsewhere.

North Carolina to Florida (?), Illinois, and Louisiana, in the coastal plain.

MALAPOENNA Adans., Fam. **2**: 447. 1763.

M. geniculata (Walt.) Coult., Mem. Torrey Club **5**: 164. 1894.

In and around ponds; rare. MONTGOMERY (with the preceding), COFFEE, IRWIN (*1422*). Also in Bryan and Glynn Counties, in the flat pine-barren region. Not seen in flower.

Virginia (?) to Florida and Louisiana, in the coastal plain. Also in Tennessee (*Gattinger*). The range of this is greatly in need of study.

PERSEA Gaert. f. Fr. & Sem. **3**: 22. 1805.

P. pubescens (Pursh] Sarg., Silva N. A. **5**: 7. *pl. 302.* 1895. "SWEET BAY."

Normally in non-alluvial swamps; also to some extent in adjacent hammocks and alluvial swamps. EMANUEL, TATTNALL, MONTGOMERY (with the preceding, and elsewhere), DODGE, TELFAIR, COFFEE (*2048*), IRWIN, BERRIEN, THOMAS. Varies in size from a shrub to a tree over a foot in diameter and 60 to 75 feet tall. Not common farther inland, but frequent in the flat country.

Virginia to Florida and Mississippi, in the coastal plain.

Leaf-anatomy studied by Kearney, Contr. U. S. Nat. Herb. **5**: 489. 1901.

CACTACEÆ.

OPUNTIA Mill., Gard. Dict. ed. 7. 1759.

O. vulgaris Mill., Gard. Dict. ed. 8. 1768. PRICKLY PEAR.

Sand-hills and hammocks. BULLOCH, EMANUEL, MONTGOMERY, DODGE, COFFEE, WILCOX, BERRIEN. Fl. May–July. Widely distributed over the state, even on rocky mountain-summits in Middle and Northwest Georgia (Bull. Torrey Club **28**: 476. 1901), if it is all the same species.

Massachusetts to Florida and Alabama, mostly within 300 miles of the coast.

PASSIFLORACEÆ.

PASSIFLORA L., Sp. Pl. 955. 1753.

P. INCARNATA L., Sp. Pl. 959. 1753. MAYPOP.

A weed, rare in our territory. TATTNALL: Near Collins; TELFAIR: Near Helena. Not seen nearer the coast, but common in the upper parts of the state, mostly in old fields.

Widely distributed in the Southeastern United States, but certainly not native in Georgia. Probably introduced from tropical America.

P. lutea L., Sp. Pl. 958. 1753.

MONTGOMERY: Oconee River swamp near Mount Vernon, June 27, 1903. More common in the upper third of the coastal plain, and in Middle Georgia.

Widely distributed in the Eastern United States south of latitude 40°.

VIOLACEÆ.

VIOLA L., Sp. Pl. 933. 1753. VIOLETS.

V. pedata L., l. c.

EMANUEL: Near Swainsboro, April 5, 1904. Possibly not native. More common farther inland.

Widely distributed in the Eastern United States, but only as a weed in some places.

V. villosa Walt., Fl. Car. 219. 1788.

Sand-hills and hammock-like places; rare. BULLOCH, TATTNALL. More common in Middle Georgia.

New Jersey to Florida, etc. Range not well known.

V. primulæfolia L., Sp. Pl. 934. 1753.

Damp woods, etc.; not common. SCREVEN, MONTGOMERY, BERRIEN, COLQUITT. Fl. March–April. More common farther inland.

Widely distributed in the Eastern United States.

V. sp. (Related to *V. primulæfolia* but evidently distinct and probably undescribed).

COLQUITT: Swamp of Ochlocknee Creek near Moultrie, Sept. 25, 1902. (*675*.)

V. denticulosa Pollard; Harper, Bull. Torrey Club **28**: 475. 1901.

Wet woods, COFFEE: Several stations near Douglas (*724*, type). BULLOCH: Several stations near Statesboro (*2166*). Quite abundant at both places, and doubtless grows elsewhere in the region. Fl. April. Seen also in Charlton County.

Not yet detected elsewhere.

V. lanceolata L., Sp. Pl. 934. 1753.

EMANUEL: Between Kemp and Covena, April 5, 1904, in flower. Also grows in Jefferson and Sumter Counties, in the Lower Oligocene region. Not common in Georgia.

From Nova Scotia west to Minnesota in the glaciated region, and south to Florida (?) and Texas in the coastal plain. (See Rhodora **7**: 74. 1905). Also in the mountains of Tennessee (*Gattinger*).

CISTACEÆ.

HELIANTHEMUM Tourn.; Adans., Fam. **2**: 443. 1763.

H. Carolinianum (Walt.) Mx., Fl. **1**: 307. 1803.

Halimium Carolinianum (Walt.) Grosser, Engler's Pflanzenreich 4^{193}: 44. 1903.

Dry pine-barrens. SCREVEN (*2081*), BULLOCH (*832*), EMANUEL. Doubtless grows in most of the other counties, but easily overlooked when not in flower. Fl. March–April.

North Carolina (?) to Florida and Texas, in the coastal plain.

H. ROSMARINIFOLIUM Pursh, Fl. 364. 1814.

Halimium rosmarinifolium (Pursh) Grosser, l. c. 49.

A weed in dry sandy places. SCREVEN, BULLOCH (*986*). Fl. June–July. Also noted in Effingham, Jefferson, and Pulaski Counties. Often very abundant (see Bull. Torrey Club **30**: 337–338. 1903).

South Carolina to Texas (?), in the coastal plain. Natural range and habitat unknown. Perhaps native westward, like several of its associates.

LECHEA L., Sp. Pl. 90. 1753.

? L. Torreyi Leggett; Britton, Bull. Torrey Club **21**: 251. 1894.

COFFEE: Slightly damp place at base of sand-hills of Seventeen

Mile Creek north of Douglas, July 22, 1902 (*1436*). Grows also in similar situations in Ware and Charlton Counties, in the flat country.

South Carolina to Florida and Louisiana (?), in the pine-barrens.

? **L. tenuifolia** Mx., Fl. **1** : 77. 1803.

COFFEE: Sand-hills of Satilla River (*1443*) and Seventeen Mile Creek (*1461*), July, 1902. Also in Ware County near Waycross.

Said to range nearly throughout the Eastern United States.

? **L. patula** Leggett, Bull. Torrey Club **6** : 251. 1878.

THOMAS: Intermediate pine-barrens about four miles northeast of Thomasville, Aug. 9, 1901 (*1177*).

South Carolina to Florida, and Mississippi (?) in the pine-barrens.

TURNERACEÆ.

PIRIQUETA Aubl. Pl. Guian. **1** : 298. *pl. 117.* 1775.

P. Caroliniana (Walt.) Urban, Jahrb. Kgl. Bot. Gart. Berlin **2** : 71. 1883.

TATTNALL: Sandy west bank of Ohoopee River, June 24, 1903. IRWIN: Rather dry pine-barrens near Ocilla, July 15, 1902. Rare. Fl. summer. Occurs also in Screven (near Millen), Sumter, and Charlton Counties, but usually as a weed.

North Carolina to Florida in the coastal plain, but range and habitat not fully understood. Also in South America.

THEACEÆ.

GORDONIA Ellis, Phil. Trans. **60** : 518. *pl. 11.* 1770.

G. Lasianthus L., Mant. **2** : 570. 1771. "RED BAY."

Strictly confined to non-alluvial branch- and creek-swamps. MONTGOMERY, DODGE, TELFAIR, APPLING, COFFEE (*693*), IRWIN, Fl. July–Sept. Outside of our territory it grows in Richmond (a remarkable outlying station near the fall-line) and Laurens Counties, and at several places in the flat country, including Okefinokee Swamp.

Virginia (?) to central Florida and Louisiana (?) in the coastal plain. Not at all common.

HYPERICACEÆ.

TRIADENUM Raf. Med. Rep. II. 5 : 352. 1808.

T. petiolatum (Walt.) Britton. Ill. Fl. **2** : 437. *f. 2465.* 1897.

Swamps of the muddy rivers. MONTGOMERY, TELFAIR, COFFEE. Fl. September. More common in the Eocene and Lower Oligocene regions. Not known nearer the coast.

New Jersey to Florida (?), Missouri, and Louisiana, in the coastal plain.

T. Virginicum (L.) Raf., Fl. Tell. **3** : 79. 1836.

Moist pine-barrens; not common. COFFEE, WILCOX. Fl. summer. Extends inland at least to Sumter County, and coastward to Okefinokee Swamp.

From Nova Scotia west to Manitoba and Nebraska (?) in the glaciated region, and south to northern Florida and Louisiana in the coastal plain.

Anatomy and morphology discussed by Holm, Am. Jour. Sci. IV. **16** : 369–376. *f. 1–8.* Nov. 1903.

SAROTHRA L., Sp. Pl. 272. 1753.

S. gentianoides L., l. c.

Usually a roadside weed in sandy soil, but also on rock outcrops in TATTNALL and DOOLY. Perhaps native on sand-hills as well. Fl. all summer. Grows also on granite outcrops in Middle Georgia, and as a weed nearly all over the State.

Widely distributed in the Eastern United States, but natural range and habitat uncertain.

Stem-anatomy studied by W. E. Britton, Bull. Torrey Club **30** : 595. 1903.

HYPERICUM L., Sp. Pl. 783. 1753.

H. maculatum Walt., Fl. Car. 189. 1788.

MONTGOMERY: Very dry pine-barrens near Glenwood, July 1, 1903. More common farther inland, often as a weed. Fl. June–July.

Widely distributed in the Eastern United States, but probably not everywhere native.

H. myrtifolium Lam., Encyc. **4** : 180. 1796.

Shallow ponds of all kinds (sand-hill, cypress, etc.), more

rarely in moist or even rather dry pine-barrens. BULLOCH, TATTNALL, TELFAIR, COFFEE, WILCOX, IRWIN, BERRIEN, DOOLY, COLQUITT, THOMAS. Fl. June–Aug. Nearly throughout the pine-barren region of Georgia.

South Carolina to central Florida and Mississippi, in the pine-barrens.

H. fasciculatum Lam., Encyc. 4 : 160. 1796.

Moist pine-barrens, branch-swamps, and shallow ponds; common throughout the pine-barrens of Georgia. Fl. April–Aug. (I have not been able to distinguish *H. aspalathoides* Willd., which differs chiefly in size.)

North Carolina to central Florida and Texas, in the pine-barrens.

H. galioides pallidum Mohr. Contr. U.S. Nat. Herb. 6: 621. 1901.

Swamps of streams of the second class (see p. 28). TATTNALL: Ohoopee River; MONTGOMERY and TELFAIR: Gum Swamp Creek. Fl. July. More common in the Lower Oligocene region.

Reported also from Florida, Alabama, and Mississippi, in the coastal plain.

H. opacum T. &. G., Fl. 1 : 163. 1838.

Intermediate pine-barrens, etc. APPLING, COFFEE, IRWIN, DOOLY, COLQUITT, THOMAS. Fl. summer. Extends inland to Sumter County and coastward to Camden, but not recorded east of the Altamaha River and its tributaries.

South to central Florida and west to Louisiana, in the pine-barrens.

H. acutifolium Ell., Sk. 2: 26. 1821.

Shallow cypress ponds. IRWIN, COLQUITT. More common in Sumter County, where it flowers July–September.

Also reported from Florida and Alabama, but distribution not well understood.

H. gymnanthum Engelm. & Gray, Bost. Jour. Nat. Hist. 5: 212. 1847.

BULLOCH: Shallow pine-barren pond near Bloys, June 27, 1001 (*957*). More common in the Lower Oligocene region.

Said to be widely distributed in the Eastern United States (but perhaps not everywhere native?).

ASCYRUM L., Sp. Pl. 788. 1753.

A. stans Mx., Fl. **2**: 77. 1803.

Moist pine-barrens; not common. DODGE, COFFEE, BERRIEN, COLQUITT. Fl. summer. Extends inland to Sumter County and coastward to Camden.

New Jersey to central Florida, Arkansas, and Texas, mostly in the coastal plain.

Leaf-anatomy described by Kearney, Contr. U. S. Nat. Herb. **5**: 495. 1901.

A. pumilum Mx., l. c.

Dry and intermediate pine-barrens, etc. TATTNALL, COFFEE (*676*), IRWIN, BERRIEN, DOOLY, COLQUITT, THOMAS.

South to Florida and west to Mississippi, in the pine-barrens.

MALVACEÆ.

HIBISCUS L., Sp. Pl. 693. 1753

H. aculeatus Walt., Fl. Car. 177. 1788.

Intermediate pine-barrens; rather rare. TATTNALL, COFFEE, WILCOX. Fl. July–Aug. Also in Sumter, Lee, Lowndes, Charlton, and Chatham Counties.

South Carolina to northern Florida and Louisiana, in the pine-barrens.

SIDA L., Sp. Pl. 683. 1753.

S. RHOMBIFOLIA L., Sp. Pl. 684. 1753. TEA WEED.

Streets of Douglas and Tifton. Also in several other South Georgia cities. Fl. July–Aug.

North Carolina to Florida and Louisiana, in the coastal plain. Introduced from the tropics.

CALLIRHOE Nutt., Jour. Acad. Phila. **2**: 181. 1821.

C. Papaver (Cav.) Gray, Mem. Am. Acad. II. **4**: 17. 1848.

TATTNALL: Sandy west bank of Ohoopee River, June 24, 1903. Rare. June–July. Also in Pulaski (according to Croom, Am. Jour. Sci. **28**: 168. 1835) and Dooly Counties in the Lower Oligocene region.

South to Florida and west to Arkansas (?) and Texas (?), in the pine-barrens.

VITACEÆ.

PARTHENOCISSUS Planch. in DC. Mon. Phan. 5^2 : 447. 1887.

P. quinquefolia (L.) Planch., l. c. 448. VIRGINIA CREEPER.

Hammocks, bluffs, etc. BULLOCH, EMANUEL, MONTGOMERY, WILCOX, BERRIEN. Fl. early summer. More common farther inland.

Widely distributed in Eastern North America. Also in Cuba (?) and the Bahamas.

AMPELOPSIS Mx., Fl. 1 : 159. 1803.

A. arborea (L.) Rusby, Mem. Torrey Club 5 : 221. 1894.

Hedera arborea (L.) Walt.; *Cissus stans* Pers.; *Vitis bipinnata* (Mx.) T. & G.

Swamps of the muddy rivers. MONTGOMERY: Near Mount Vernon; TELFAIR: Near Lumber City; COFFEE: Barrow's Bluff. Fl. June. More common in the Lower Oligocene region, where it is often a weed along fences, etc.

Virginia to Florida, Illinois, and Mexico, in the coastal plain. Also in Cuba.

VITIS L., Sp. Pl. 200. 1753.

V. æstivalis Mx., Fl. 2 : 230. 1803. WILD GRAPE.

MONTGOMERY: Stallings' Bluff on the Oconee River near Mount Vernon, June 30, 1903. Fl. late spring. Widely distributed over the state, mostly inland.

Nearly throughout Eastern North America.

V. rotundifolia Mx., Fl. 2 : 231. 1803. MUSCADINE. BULLACE.

Hammocks, bluffs, and non-alluvial creek-swamps. EMANUEL, TATTNALL, MONTGOMERY, DODGE, TELFAIR, COFFEE, BERRIEN. Fl. May. Grows nearly all over the state in a variety of habitats, from muddy swamps to drifting sands on the coast.

Widely distributed in the Southeastern United States.

V. sp.

An unidentified species closely related to the preceding is abundant in the Oconee River swamp near Stallings' Bluff, MONTGOMERY County, but was not collected for lack of flowers and fruit.

RHAMNACEÆ.

CEANOTHUS L., Sp. Pl. 195. 1753.

C. Americanus L., l. c. RED-SHANK.

Bluffs, dry pine-barrens, etc. BULLOCH, MONTGOMERY, COFFEE, WILCOX. Fl. May–June. Not noticed nearer the coast, but common farther inland, particularly in Middle Georgia.

Widely distributed in the Eastern United States.

C. microphyllus Mx., Fl. **1** : 154. 1803.

Dry pine-barrens and sand-hills; frequent but nowhere abundant. Noted in most of the counties. Fl. late spring. Extends inland to Sumter Co.

Reported also from several stations in East Florida.

BERCHEMIA Neck.; DC., Prodr. 2 : 23. 1825.

B. scandens (Hill) Trel., Trans. Acad. Sci. St. L. **5**: 364. 1889. RATTAN VINE.

Creek- and river-swamps. TATTNALL, MONTGOMERY, TELFAIR. More common in the Lower Oligocene region, but extends coastward to Camden County.

Virginia to Florida, Missouri, and Texas, in the coastal plain; also in Northwest Georgia (See Bull. Torrey Club **28** : 474. 1901) and adjacent Tennessee (*Gattinger*).

Leaf-anatomy described by Kearney, Contr. U. S. Nat. Herb. **5** : 494. 1901.

ACERACEÆ.

ACER L., Sp. Pl. 1055. 1753.

A. rubrum L., l. c. MAPLE. REDBUD.

Creek- and river-swamps, common. Fl. February. Probably grows in every county in Georgia (including varieties or closely related species which I have not attempted to distinguish).

Common throughout temperate Eastern North America. (See maps in Bulletin 59 of the U. S. Bureau of Forestry, 1905.)

ÆSCULACEÆ.

ÆSCULUS L., Sp. Pl. 344. 1753.

A. Pavia L., l. c. BUCKEYE.

Bluffs along the muddy rivers, near the inland edge of our

territory. BULLOCH, MONTGOMERY, WILCOX. Fl. March–April. Common in the upper third of the coastal plain, to which it is almost confined in Georgia. I have never noticed it above the fall-line, or nearer the coast than the above-mentioned localities.

Virginia to Middle Florida, Missouri, and Texas, mostly in the coastal plain.

CELASTRACEÆ.

EUONYMUS L., Sp. Pl. 197. 1753.

E. Americanus L., l. c.

MONTGOMERY: Stallings' Bluff on Oconee River; hammock of Gum Swamp Creek west of Erick. DOOLY: around the Rock House. Fl. May–June. More common farther inland, all the way to the mountains.

Widely distributed in the Eastern United States south of the glaciated region, mostly outside of the pine-barrens.

AQUIFOLIACEÆ.

ILEX L., Sp. Pl. 125. 1753.

I. opaca Ait., Hort. Kew. **1**: 169. 1789. HOLLY.

Hammocks, bluffs, etc. BULLOCH, EMANUEL, TATTNALL, MONTGOMERY, DODGE, TELFAIR, COFFEE, WILCOX, BERRIEN, DOOLY. Fl. April–May. Grows nearly all over Georgia in shaded places, but nowhere abundant.

Widely distributed in the Eastern United States south of latitude 41°, but said to be wanting in the higher mountains.

I. vomitoria Ait., Hort. Kew. **1**: 170. 1789.

EMANUEL: Hammock of Little Ohoopee River; MONTGOMERY: Sand-hills of Gum Swamp Creek. So rare that it may be doubted if it is indigenous in our territory. More common in the maritime counties.

Virginia to Florida and Texas, mostly near the coast.

Leaf-anatomy studied by Kearney, Contr. U. S. Nat. Herb. **5**: 296–297. 1900.

I. myrtifolia Walt., Fl. Car. 241. 1788.

Usually in cypress ponds; a handsome shrub or small tree

(See Torreya 5: 164. 1905.). Noted in every county except Emanuel, Laurens, Dodge, Telfair, Wilcox, Worth, and Thomas. Especially abundant in the central part of BERRIEN County, but elsewhere one is not likely to see it every day. Extends inland to Sumter County and coastward to the vicinity of Okefinokee Swamp.

North Carolina to Florida and Louisiana, in the pine-barrens.

I. **decidua** Walt., Fl. Car. 241. 1788.

Only in swamps of the muddy rivers, usually associated with *Quercus lyrata*. BULLOCH, MONTGOMERY, TELFAIR, COFFEE. Fl. March. Extends inland to the Palæozoic region.

Widely distributed in the Southeastern United States in muddy places (therefore not to be expected in the mountains).

I. **ambigua** (Mx.) Chapm., Fl. 270. 1860; Robinson, Syn. Fl. N. A. 1: 389. 1897; Loesener, Monog. Aquif. 482–843. 1901.

Cassine Caroliniana Walt., Fl. Car. 242. 1788. Not of Lam., 1783.

Ilex Caroliniana (Walt.) Trel., Trans. Acad. Sci. St. L. 5: 347. 1889. Not of Mill., 1768.

Hammocks and sand-hammocks. EMANUEL (*980*), MONTGOMERY. Also in similar situations in Pierce County, a little southeast of our territory.

North Carolina to Florida and Louisiana, in the pine-barrens.

I. **coriacea** (Pursh) Chapm., Fl. 270. 1860. Robinson, Syn. Fl. N. A. 1: 390. Loesener, Monog. Aquif. 136–138. 1901.

"*I. lucida* (Ait.) T. & G." of authors since 1878, but not *Prinos lucidus* Ait., according to Loesener, l. c.

Non-alluvial swamps, etc. EMANUEL (*813*), APPLING, COFFEE, DOOLY, WORTH, COLQUITT, THOMAS. Fl. May–June. Extends inland to the vicinity of Americus and Cuthbert, and coastward to Bryan County and the vicinity of Okefinokee Swamp.

Virginia to Florida and Louisiana, in the coastal plain. Also in Mexico (*Loesener*).

Leaf-anatomy described by Kearney, Contr. U. S. Nat. Herb. 5: 493. 1901.

I. glabra (L.) Gray, Man. ed. 2. 264. 1856. "GALLBERRY."

Intermediate and moist pine-barrens and branch-swamps; very common throughout. Fl. late spring. Widely distributed in South Georgia, and reported once from Middle Georgia (*C. L. Boynton*, Biltmore Bot. Stud. **1** : 144–145. 1902). A valuable honey plant. The bushes are sometimes used as coarse brooms for sweeping yards.

Nova Scotia to central Florida and Louisiana, mostly in the coastal plain. (See Rhodora **7** : 74. 1905.)

Leaf-anatomy described by Kearney, Contr. U. S. Nat. Herb. **5** : 492. 1901.

CYRILLACEÆ.

CLIFTONIA Banks; Gaert. f., Fr. & Sem. **3** : 246. *pl. 225. f. 5.* 1805.

C. monophylla (Lam.) Sarg., Silva N. A. **2** : 7. *pl. 52.* 1891. "TYTY."

C. ligustrina (Willd.) Spreng., Syst. **2** : 316. 1825.

Non-alluvial branch- and creek-swamps, etc.; common. Noted in every county except Screven, Laurens, Dodge, and Worth, and it probably grows in them too. Fl. March–April. Never seen northwest of the Altamaha Grit escarpment, but extends in the other direction to within about 25 miles of the coast. Its distribution in Georgia is thus much like that of *Pinckneya* and *Nyssa Ogeche* (see Bull. Torrey Club **32** : 147. 1905). Usually a shrub, but arborescent in the larger swamps. Its wood is said to be used to some extent for hames, and its flowers are an important source of honey.

Extreme southern South Carolina to southeastern Louisiana, in the pine-barrens.

CYRILLA L., Mant. 150. 1767.

C. racemiflora L., l. c. "TYTY."

Branch- and creek-swamps, etc.; often with the preceding but adapted to more alluvial conditions. Noted in every county except Screven, Laurens, and Appling, but not quite so abundant in our territory as *Cliftonia*. Fl. June–July. Has

a wider range in Georgia than the preceding, extending inland to Chattahoochee County in the Cretaceous region, up the Flint River to the Pine Mountains (see Bull. Torrey Club **30**: 294. 1903), and coastward to Glynn County and Okefinokee Swamp. Its maximum dimensions are less than those of *Cliftonia*, but it is equally important as a honey plant. Not a true evergreen, but most of the leaves persist well into the winter season.

Virginia to Florida and Texas, in the coastal plain (with the exception above noted).

ANACARDIACEÆ.

RHUS L., Sp. Pl. 265. 1753. SUMAC.

R. copallina L., Sp. Pl. 266. 1753.

Dry pine-barrens, hammocks, etc. (*i. e.*, in places where the flora has been largely derived from farther north). Frequent, but not abundant. Noted in most of the counties. Fl. July–Sept. Never arborescent in our territory. Widely distributed over the state, in various habitats, often a weed in old fields in the northern portions.

Ranges nearly throughout the Eastern United States, but not everywhere native.

R. aromatica Ait., Hort. Kew. **1**: 367 1789.

WILCOX: Upper Seven Bluffs on the Ocmulgee, May 17, 1904. Scarcely belongs to our flora, but common in several counties in the Eocene region, where it flowers in March.

North to Vermont and Minnesota, west to Texas.

R. Vernix L. (in part), Sp. Pl. 265. 1753. POISON SUMAC.

Branch-swamps, sand-hill bogs, etc. SCREVEN, EMANUEL, TATTNALL, MONTGOMERY, DODGE, COFFEE, WILCOX, IRWIN, BERRIEN, DOOLY, WORTH, COLQUITT. Less common in other parts of the coastal plain, and rare in Middle Georgia.

Widely distributed in the Eastern United States, mostly in the glaciated region and coastal plain.

R. Toxicodendron L., Sp. Pl. 266. 1753. POISON OAK.

Dry pine-barrens and sand-hills; not common. BULLOCH (*948*).

TATTNALL, COFFEE, BERRIEN. Pretty well scattered over the state.

New Jersey (?) to Florida and Texas.

R. radicans L., l. c. POISON OAK.

Creek- and river-swamps and other damp shaded places. SCREVEN, TELFAIR, COFFEE, BERRIEN. Fl. May. More common farther inland.

Widely distributed in the Eastern United States, apparently mostly a weed in the North.

EMPETRACEÆ.

CERATIOLA Mx., Fl. 2 : 222. 1803.

C. ericoides Mx., l. c. "ROSEMARY."

For illustrations see Curt. Bot. Mag., **54** : *pl. 2758.* 1827; Bull. Torrey Club **30** : 284. *f. 2.* 1903, and *pl. xxi, f. 2.* of this volume.

EMANUEL: Sand-hammock on Fifteen Mile Creek near Rosemary Church, June 28, 1901 (*975*). Known also from the fall-line sand-hills in Richmond County, where it grows larger and more luxuriantly; and reported from the sand-hills of Brier Creek, at the northwestern corner of Burke County, by Croom (Am. Jour. Sci. **26** : 315. 1834. See also Bull. Torrey Club **32** : 160. 169, 1905.)

South Carolina to central Florida and Mississippi, in the coastal plain. Our plant bears a striking superficial resemblance to species of *Darwinia* and *Calycothrix*, two Myrtaceous genera of western Australia.

EUPHORBIACEÆ.

EUPHORBIA L., Sp. Pl. 450. 1753.

E. Floridana Chapm., Fl. 401. 1860.

Only in the extreme southwest end of our territory. DECATUR: High sand-hills beyond Recovery, Aug. 14, 1903 (*1931*).

Known otherwise only from West Florida and southwestern Alabama. (See Bull. Torrey Club **32** : 162. 1905.)

E. corollata L., Sp. Pl. 450. 1753.

Sand-hills, dry pine-barrens, etc.; not common. MONTGOMERY COFFEE (*1458*), IRWIN, BERRIEN, COLQUITT, THOMAS. Fl.

April–Nov. More common farther inland. A weed in old fields in Middle Georgia.

Widely distributed in the Eastern United States, but natural range uncertain.

E. eriogonoides Small, Bull. Torrey Club **25**:614. 1898.

Normally in intermediate pine-barrens; rare. BULLOCH: near Bloys (*846*); BERRIEN: near Adel (*2196*). Fl. May–June. These are probably the only natural stations known for it. At the type-locality (Darien Junction, McIntosh Co.), also near Pinebloom and Tifton, and in Wayne County between Jesup and Screven, it grows in rather damp sand along railroads. Mr. Curtiss's specimen from Pearson, COFFEE Co. (see p. 124) had a similar habitat.

Reported also from Florida, probably in similar situations.

E. gracilis Ell., Sk. **2**: 657. 1824.

E. gracilis rotundifolia Wood, Class-book 627. 1861.

Normally on sand-hills, more rarely in dry pine-barrens. BULLOCH (*826*), EMANUEL, TATTNALL, MONTGOMERY, TELFAIR, COFFEE, DECATUR. Fl. April–Aug. Extends inland (naturally) to the vicinity of Dublin and Hawkinsville, and coastward to Bryan and Charlton Counties. More common as a weed along railroads, like the preceding, extending as far inland as Sandersville in this way. Early in the season it is almost leafless. When fully developed its leaves vary from linear to orbicular, or even broader. (Wood's variety is nothing but one of the extreme variations, connected with the other forms by all possible gradations.) *E. Ipecacuanhæ* L., which replaces this on the fall-line sand-hills of Richmond County, exhibits similar variations, as has been noted by Chapman, Wood, DeVries, and others.

South Carolina to Florida, in the coastal plain.

E. MACULATA L., Sp. Pl. 455. 1753.

A common weed, mostly along railroads. Still commoner in the older-settled parts of the state. Seems to grow between the rails of every railroad in the Eastern United States (from Massachusetts to Florida at least).

Throughout the United States east of the Rocky Mountains, but natural range and habitat unknown.

E. cordifolia Ell., Sk. **2** : 656. 1824.

COFFEE: Hammocks and sand-hills of Seventeen Mile Creek; rather rare. Known also from Richmond (*A. Cuthbert*), Dooly, and Sumter Counties, farther inland, and Cumberland Island.

South Carolina to central Florida and Mississippi, in the coastal plain.

JATROPHA L., Sp. Pl. 1006. 1753.

J. stimulosa Mx., Fl. **2**: 216. 1803. "NETTLE."

Sand-hills and dry pine-barrens; not common, and still less abundant. BULLOCH, EMANUEL, MONTGOMERY, COFFEE, BERRIEN, THOMAS. Fl. April–Sept. Inland to Middle Georgia and coastward to Cumberland Island.

Virginia to South Florida, Arkansas, and Texas, mostly in the coastal plain.

STILLINGIA L., Mant. **1** : 19. 1767.

S. sylvatica L., Mant. **1** : 126. 1767. "QUEEN'S DELIGHT."

Dry pine-barrens and sand-hills; common but not very abundant. Fl. April–July. Pretty widely distributed over the coastal plain of Georgia, and seen once in Newton County, Middle Georgia.

Virginia to central Florida, Arkansas, and Texas, confined to the coastal plain as far as known, with the above-mentioned exception.

S. aquatica Chapm., Fl. 405. 1860.

Cypress ponds; rather rare. TATTNALL, APPLING, COFFEE, BERRIEN. Fl. April–July. Extends inland to Ellaville (see Bull. Torrey Club **27**: 429. 1900), in the Eocene region, and the pine-barrens of Sumter and Lee Counties, in the Lower Oligocene region, and coastward to the vicinity of Waycross.

South Carolina to West Florida in the coastal plain, and only in the pine-barrens as far as known, with the above-mentioned exception.

For some morphological notes see Bull. Torrey Club **28** : 474. 1901.

SEBASTIANA Spreng., Neue Endeck. 2: 118. pl. 3. 1821.

S. ligustrina (Mx.) Muell. Arg. in DC. Prodr. 15^2 : 1165. 1862.

Hammocks, river-banks, etc. TATTNALL, MONTGOMERY, TELFAIR, COFFEE. Fl. June. Extends inland to the fall-line in Glascock County, and to some extent coastward.

North Carolina to Florida and Louisiana, in the coastal plain.

TRAGIA L., Sp. Pl. 980. 1753.

T. linearifolia Ell. Sk. 2 : 563. 1824.

? *T. urens linearis* Mx., Fl. 2 : 175. 1803.

Dry pine-barrens and sand-hills; not common. BULLOCH (*834*), WILCOX.

Also in Florida and southwestern Alabama.

CROTONOPSIS Mx., Fl. 2 : 185. 1803.

C. linearis Mx., Fl. 2 : 186. *pl. 46.* 1803.

Rock outcrops. TATTNALL, DOOLY (*1956*). Fl. summer. Also occurs on granite outcrops in Middle Georgia.

Total range and habitat uncertain. *C. spinosa* Nash, which grows in the lime-sink regions of Mitchell and Lowndes Counties, may not be distinct from this.

CROTON L., Sp. Pl. 1004. 1753.

C. argyranthemus Mx., Fl. 2 : 215. 1803.

Chiefly on sand-hills; less frequently in dry pine-barrens. EMANUEL (*984*), TATTNALL, MONTGOMERY, COFFEE, BERRIEN, DOOLY, DECATUR. Fl. May–Aug. Extends inland to Dooly, Mitchell, Miller, and Early Counties in the Lower Oligocene region, and coastward to Liberty and Charlton Counties.

South Carolina to Florida and Texas, in the pine-barrens.

C. GLANDULOSUS L., Amoen. Acad. 5 : 409. 1760.

Streets of Tifton, Sept. 27, 1902. More common in the older cities of South Georgia. Fl. May–Oct.

Widely distributed in the Southeastern United States and tropical America. Natural range and habitat unknown. The North American forms have been referred to several varieties, most of which are not known in a state of nature and have probably originated since this country was settled by civilized man.

POLYGALACEÆ.

POLYGALA L., Sp. Pl. 701. 1753.

P. cymosa Walt., Fl. Car. 179. 1788.

Chiefly in cypress ponds; common all over the pine-barren region of Georgia (wherever such ponds exist). Fl. May–Sept.

Delaware to central Florida and Louisiana, in the pine-barrens.

P. ramosa Ell., Sk. 2 : 186. 1822.

Intermediate and moist pine-barrens; nearly as common as the preceding, flowering at the same time, and having about the same general distribution in Georgia and elsewhere.

P. lutea L., Sp. Pl. 705. 1753.

Intermediate and moist pine-barrens; frequent but not abundant, throughout the pine-barren region of Georgia and a little farther inland. Fl. April–Sept.

Long Island to central Florida and Louisiana, in the coastal plain.

P. nana [Mx.] DC., Prodr. 1 : 328. 1815.

Dry and intermediate pine-barrens ; not abundant. BULLOCH (*871*), EMANUEL, TATTNALL, COFFEE (*713*), BERRIEN. Fl. April–June. Not observed in other parts of the state.

South Carolina to central Florida and Louisiana, in the pine-barrens, with the exception of some outlying stations in Alabama reported by Dr. Mohr (Contr. U. S. Nat. Herb. **6** : 589. 1901).

P. cruciata L., Sp. Pl. 706. 1753.

Moist pine-barrens; not common. MONTGOMERY, COFFEE, IRWIN, COLQUITT, DECATUR. Fl. all summer. Pretty well scattered over South Georgia, and extending inland to Meriwether County (see Bull. Torrey Club, **30** : 294. 1903).

Widely distributed in the Eastern United States, mostly in the glaciated region and coastal plain (see Rhodora **7** : 74. 1905).

P. Harperi Small, Fl. 688. 1903.

BULLOCH: Rather dry (intermediate) pine-barrens near Bloys, June 15, 1901 (*896*, type). More common in similar situations in the flat country: Effingham (*Curtiss 6839*, July 10, 1901), Chatham, Bryan, Camden, Charlton, and Ware Counties. Fl. June-Aug.

Also known from Louisiana, and will doubtless turn up in other states.

(?) **P. Chapmani** T. & G., Fl. **1** : 131. 1838.

TATTNALL: Rock outcrops near Ohoopee River (*1853*) and Pendleton Creek, also in intermediate pine-barrens near Ohoopee. MONTGOMERY: Dry pine-barrens near Mount Vernon (*1865*). IRWIN: Rather dry pine-barrens around a shallow pond near Fitzgerald (*1421*). Fl. June–July. Also in Lowndes County.

South to Florida and west to Mississippi, in the pine-barrens.

P. incarnata L., Sp. Pl. 701. 1753.

Dry and intermediate pine-barrens; rather rare and inconspicuous. BULLOCH, TATTNALL, APPLING, IRWIN, BERRIEN. Fl. May–Sept. Inland to Sumter County, coastward to Ware County, and at a few stations in the mountains.

New Jersey to Florida, Illinois, and Texas, mostly in the pine-barrens.

P. setacea Mx., Fl. **2** : 52. 1803.

Intermediate pine-barrens. Even less conspicuous than the preceding and probably still rarer. COFFEE (*1439*), BERRIEN. Fl. May–July. Not known farther inland, but more frequent in the flat pine-barrens toward the coast.

North Carolina to central Florida, in the pine-barrens.

P. polygama Walt., Fl. Car. 179. 1788.

BULLOCH: Dry pine-barrens near Bloys, June, 1901 (*945*). More common farther inland, in Middle Georgia and elsewhere. Fl. May–July.

Widely distributed in the Eastern United States, but probably not everywhere native.

P. grandiflora Walt., l. c.

Dry pine-barrens; rare. BULLOCH (*958*), IRWIN. Also in Sumter and Charlton Counties. Fl. June–Sept.

South Carolina to central Florida and Mississippi, in the coastal plain.

OXALIDACEÆ.

OXALIS L., Sp. Pl. 433. 1753.

O. recurva Ell., Sk. **1**:526. 1821; Small, Bull. Torrey Club **21**:471–474. *pl. 422.* 1894.

SCREVEN: Dry pine-barrens near Sylvania, April 1, 1904 (*2082*). EMANUEL: Near Swainsboro, April 5, 1904. Possibly not native. More common farther inland, but usually as a weed.

Widely distributed in the Southeastern United States, but natural range and habitat uncertain.

LINACEÆ.

LINUM L., Sp. Pl. 277. 1753.

L. Floridanum [Planch.] Trel., Trans. St. L. Acad. Sci. **5**:13. 1886.

Intermediate pine-barrens; not abundant. BULLOCH (*949*), TATTNALL, MONTGOMERY, IRWIN, DECATUR. Fl. June–July. Inland to Washington and Sumter Counties and coastward to Ware and Charlton.

South Carolina to central Florida and Louisiana (?), in the coastal plain.

LEGUMINOSÆ.

PHASEOLUS L., Sp. Pl. 723. 1753.

P. polystachyus (L.) B. S. P., Prel. Cat. N. Y. 15. 1888; MacM., Met. Minn. 312. 1892.

Wooded bluffs along the muddy rivers. MONTGOMERY: Stallings' Bluff; TELFAIR: near Lumber City; WILCOX: Upper Seven Bluffs. Fl. June. More common farther inland and northward.

Widely distributed in the Eastern United States.

APIOS Moench, Meth. 165. 1794.

A. tuberosa Moench, l. c.

COLQUITT: Branch-swamps near Moultrie, Sept. 23, 1902, Aug. 22, 1903. Fl. August. Known also from Sumter and Camden Counties.

Widely distributed in the Eastern United States.

CLITORIA L., Sp. Pl. 753. 1753.

C. Mariana L., l. c.

Sand-hills; rare. BULLOCH, MONTGOMERY. Fl. May–Aug. Also in Middle Georgia, in Sumter County, and on Cumberland Island, usually as a weed.

Widely distributed in the Eastern United States, but natural range and habitat uncertain.

BRADBURYA Raf., Fl. Lud. 104. 1817.

B. Virginiana (L.) Kuntze, Rev. **1**: 164. 1891.

MONTGOMERY: Bluff along Oconee River above Ochwalkee, July 1, 1903. More common in the upper third of the coastal plain, but usually a weed.

Maryland to South Florida, Arkansas, and Texas, in the coastal plain; also in tropical America, where it perhaps originated.

GALACTIA P. Br., Hist. Jam. 298. 1756.

G. mollis Mx., Fl. **2**: 61. 1803.

BULLOCH: Dry pine-barrens near Bloys (*825*). TATTNALL: Sandy west bank of Ohoopee River, June 24, 1903. Also in Dooly, Sumter, and Lee Counties, in the Lower Oligocene region.

North Carolina to Florida, in the pine-barrens.

G. regularis (L.) B. S. P., Prel. Cat. N. Y. 14. 1888; Britton Mem. Torrey Club **5**: 208. 1892.

Sand-hills, especially toward the hammocks at their bases. TATTNALL, MONTGOMERY, TELFAIR, COFFEE (*1450*), BERRIEN. Fl. June–July. Inland to Richmond County and coastward to Effingham.

New York to Florida and Louisiana, in the coastal plain.

G. erecta (Walt.) Vail, Bull. Torrey Club **22** : 502. 1895.

Dry pine-barrens; infrequent. BULLOCH (*824*), EMANUEL, MONTGOMERY, COFFEE, IRWIN. Fl. June–July. Also in Johnson, Laurens, and Sumter Counties, in the Lower Oligocene region.

North Carolina to West Florida and Louisiana, in the pine-barrens.

ERYTHRINA L., Sp. Pl. 706. 1753.

E. herbacea L., l. c.

Figured in Meehan's Native Flowers and Ferns II. **2** : 45–48. *pl. 11*. 1880.

Hammocks; rare. COFFEE, WILCOX. Fl. May. Also occurs in a few similar places along the Oconee, Flint, and Chattahoochee Rivers, in the older parts of the coastal plain.

North Carolina (?) to South Florida and Texas (?), in the coastal plain.

DOLICHOLUS Medic., Vorles. Churpf. Phys. Ges. **2** : 354. 1787.

D. simplicifolius (Walt.) Vail, Bull. Torrey Club **26** : 114. 1899. "DOLLAR WEED."

Sand-hills and dry pine-barrens; common but not abundant. BULLOCH, EMANUEL, TATTNALL, MONTGOMERY, COFFEE, BERRIEN, COLQUITT, THOMAS. Fl. April–Sept.

Virginia to Florida and Louisiana, in the coastal plain.

LESPEDEZA Mx.. Fl. **2** : 70. 1803.

L. hirta (L.) Ell., Sk. **2** : 207. 1822.

Sand-hills; rather rare. DODGE (*1978*), BERRIEN. Fl. September. More common farther inland, particularly in Middle Georgia.

Widely distributed in the Eastern United States, but often merely a weed in old fields.

L. repens (L.) Bart. Prodr. Fl. Phila. **2** : 77. 1818.

COLQUITT: Sand-hills of Okapilco Creek near Moultrie, Sept. 1902 (*1661*).

General distribution and habitat like that of the preceding.

L. STRIATA (Thunb.) H. & A., Bot. Beechey 226. 1836. (JAPAN CLOVER.)

A common weed along roads and railroads, particularly in and near towns. Now distributed nearly all over Georgia and other southeastern states. Fl. Aug.–Oct.

Native of Eastern Asia.

MEIBOMIA Heist.; Fabr., Enum Pl. Hort. Helmst. 168. 1759. (DESMODIUM Desv.) BEGGAR-LICE.

M. tenuifolia (T. & G.) Kuntze, Rev. 1 : 198. 1891.

Sand-hills and dry pine-barrens. IRWIN, BERRIEN, COLQUITT (*1660*). Fl. Sept.–Oct.

North Carolina to Florida and Louisiana, in the coastal plain.

M. Michauxii Vail, Bull. Torrey Club 23 : 140. 1896.

Desmodium rotundifolium (Mx.) DC., Prodr. 2 : 330. 1825.

Wooded bluffs along the muddy rivers. TELFAIR: Near Lumber City; WILCOX: Upper Seven Bluffs. More common farther inland and northward.

Widely distributed in the Eastern United States.

M. arenicola Vail, l. c.

Desmodium lineatum (Mx.) DC., l. c.

Dry pine-barrens; not common. MONTGOMERY, IRWIN (*1704*) BERRIEN, COLQUITT. Fl. Sept.–Oct. Also in Sumter and Charlton Counties.

Maryland to Florida and Louisiana, in the coastal plain.

M. nudiflora (L.) Kuntze, Rev. 1 : 197. 1891.

MONTGOMERY: Wooded bluffs on both sides of the Oconee River near Mount Vernon and Ochwalkee. Fl. June–Aug. More common farther inland and northward.

A characteristic inhabitant of mesophytic forests nearly throughout temperate Eastern North America.

STYLOSANTHES Sw., Prodr. 108. 1788.

S. biflora (L.) B. S. P., Prel. Cat. N. Y. 13. 1888; Britton, Mem. Torrey Club 5 : 202. 1894.

Sand-hills, dry pine-barrens, etc.; not abundant. BULLOCH (*946*), EMANUEL, TATTNALL, MONTGOMERY, COFFEE, BERRIEN, DOOLY, COLQUITT, DECATUR. Fl. May–July. Pretty well distributed over South Georgia, also in several places in Middle Georgia, where it is perhaps only a weed.

Widely distributed in the Eastern United States. Also in Mexico and Africa (?).

ZORNIA Gmel., Syst. **2** : 1096. 1791.

Z. bracteata (Walt.) Gmel., l. c.

Sand-hills; rare. EMANUEL, MONTGOMERY. Also farther inland, in Laurens and Sumter Counties, and on Cumberland Island. Sometimes a weed.

Virginia to central Florida and Mexico, in the coastal plain. Also in Africa.

ÆSCHYNOMENE L., Sp. Pl. 213. 1753.

A. Virginica (L.) B. S. P., Prel. Cat. N. Y. 13. 1888; Britton, Mem. Torrey Club **5** : 202. 1894.

BERRIEN: Edge of branch-swamp, Tifton, Sept. 19, 1900. Not seen elsewhere in the region, and perhaps not indigenous. It is evidently a mere weed in some other parts of South Georgia.

New Jersey to Florida and Louisiana, in the coastal plain. Perhaps native near the coast.

KUHNISTERA Lam., Encyc. **3**: 370. 1789.

K. pinnata (Walt.) Kuntze, Rev. **1** : 192. 1891.

Petalostemon corymbosus Mx., Fl. **2** : 50. 1803.

Sand-hills; common. Noted in every county except Screven, Laurens, Coffee (which is rather surprising), Worth, and Mitchell; but there is no known reason why it should not grow in these also. Fl. Sept.–Oct Extends inland to the fall-line in Richmond and Glascock Counties.

North Carolina to Florida and Mississippi, in the coastal plain.

PETALOSTEMON Mx., Fl. **2** : 48. 1803.

P. albidus [T. & G.] Small, Fl. 630. 1903.

Dry pine-barrens, etc. DODGE, WORTH, COLQUITT, THOMAS. Fl. Aug.–Sept. More common in the Lower Oligocene region, but occurs also in Camden County.

Also in Florida and southeastern Alabama.

AMORPHA L., Sp. Pl. 713. 1753.

A. fruticosa L., l. c.

Swamps and banks of rivers rising north of our territory.

TATTNALL, TELFAIR, COFFEE. Fl. spring. Pretty well scattered over the state in more or less calcareous situations.

Widely distributed in the Eastern United States, but distribution not fully understood.

A. herbacea Walt., Fl. Car. 179. 1788.

Dry pine-barrens mostly. BULLOCH (*895*, *942*), TATTNALL, MONTGOMERY, COLQUITT. Fl. June. Also in Lee and Charlton Counties.

North Carolina to central Florida, in the coastal plain.

PSORALEA L., Sp. Pl. 762. 1753.

(Our three species if standing alone might well be regarded as representatives of as many different genera.)

P. gracilis Chapm.; T. & G., Fl. **1**: 303. 1838. (As synonym.)

Dry or intermediate pine-barrens. BULLOCH, EMANUEL (805), WILCOX. Fl. May–June. Also in Chatham and Bryan Counties, near the coast, and in Florida.

P. canescens Mx., Fl. **2**: 57. 1803. (PLATE XXII, FIG. 1).

Dry pine-barrens and sand-hills; frequent but not abundant, BULLOCH (*821*), EMANUEL, TATTNALL, TELFAIR, COFFEE, WILCOX, IRWIN, BERRIEN, COLQUITT, DECATUR. Fl. May–June. Inland to Richmond (*A. Cuthbert*), Johnson, and Sumter Counties, and coastward to Camden.

This, like the *Baptisias* which it so much resembles, and like some of its western relatives, becomes a tumble-weed in the fall.

North Carolina to central Florida and Alabama in the coastal plain, mostly in the pine-barrens.

P. Lupinellus Mx., Fl. **2**: 58. 1803.

Sand-hills, or more rarely in dry pine-barrens. BULLOCH (*875*), EMANUEL, TATTNALL, MONTGOMERY, DODGE, WILCOX, COFFEE. Fl. June–July. Inland to Johnson, Laurens, Pulaski, Dooly, Sumter, and Lee Counties in the Lower Oligocene region, and coastward to Bryan.

North Carolina to central Florida, in the pine-barrens.

TIUM Medic., Vorles. Churpf. Phys. Ges. **2**: 73. 1787.

T. apilosum (Sheldon) Rydb.; Small, Fl. 619, 1903.

Astragalus glaber Mx., not Lam.

Sand-hills and very dry pine-barrens; not abundant. BULLOCH (*907*, *914*), EMANUEL, TATTNALL. Fl. June. Also in Richmond (*A. Cuthbert*), Johnson, and Sumter Counties.

North Carolina to Florida (?), in the coastal plain, mostly in the pine-barrens.

T. intonsum (Sheldon) Rydb., l. c.

Astragalus villosus Mx., not Gueldenst.

BULLOCH: Dry pine-barrens near Bloys, June 11, 1901 (*872*). Also in Laurens and Dooly Counties, in the Lower Oligocene region, where it flowers in March and April.

South Carolina to northern Florida and Alabama, in the coastal plain.

WISTARIA Nutt., Gen. **2**:115. 1818.

W. frutescens (L.) Poir., Tab. Encyc. **3**:674. 1823.

Branch- and creek-swamps; not common. EMANUEL (*2092*), TATTNALL, TELFAIR, WILCOX. Fl. April–Aug. Probably more common in the upper third of the coastal plain.

Virginia to Florida and westward, in the coastal plain.

CRACCA L., Sp. Pl. 752. 1753.

TEPHROSIA Pers., Syn. **2**:328. 1803.

C. Virginiana L., l. c. "DEVIL'S SHOESTRING."

Dry pine-barrens and sand-hills, abundant throughout. Grows nearly all over the state, even on mountain-summits in Northwest Georgia (Pigeon Mountain, 2329 feet), but less common north of the fall-line.

Widely distributed in the Eastern United States, perhaps usually as a weed northward.

C. hispidula (Mx.) Kuntze, Rev. **1**:175. 1891.

Intermediate pine-barrens; rare. BULLOCH (*849*), BERRIEN. Associated at both places with *Euphorbia eriogonoides*. Fl. May–June. Also in Chatham and Bryan Counties.

Virginia to Florida and Mississippi, in the pine-barrens.

INDIGOFERA L., Sp. Pl. 751. 1753.

I. Caroliniana Walt., Fl. Car. 187. 1788.

Sand-hills, hammocks, etc. BULLOCH, MONTGOMERY, DODGE,

TELFAIR, APPLING, COFFEE, BERRIEN. Fl. June–Aug. Extends inland to the Pine Mountains of Middle Georgia (see Bull. Torrey Club **30** : 294. 1903), and coastward to Cumberland Island, but in some places only a weed.

North Carolina to Florida and Louisiana, in the coastal plain, with the above-mentioned exception.

TRIFOLIUM L., Sp. Pl. 794. 1753.

T. REPENS L., Sp. Pl. 767. 1753. WHITE CLOVER.

Lulaville and Fitzgerald, May 17, 1904. Common in Middle Georgia and northward, introduced from Europe.

LUPINUS L., Sp. Pl. 721. 1753.

L. villosus Willd., Sp. Pl. **3** : 1029. 1805. (PLATE XXII, FIG. 2).

Dry and intermediate pine-barrens; not abundant. TATTNALL (*2148*), BERRIEN. Fl. April.

North Carolina to northern Florida and Louisiana, in the pine-barrens.

L. diffusus Nutt., Gen. **2** : 93. 1818.

Sand-hills; not common. BULLOCH, EMANUEL (2097), TATTNALL, COFFEE, WILCOX. Fl. April. Extends inland to Richmond and Laurens Counties.

North Carolina to central Florida and Mississippi, in the coastal plain.

L. perennis L., Sp. Pl. 721. 1753.

? *L. gracilis* Nutt., Jour. Acad. Phila. **7** : 115. 1834.

Sand-hills; not common. BULLOCH (*969*), TATTNALL, MONTGOMERY, COFFEE, BERRIEN. Fl. April. Also on the sandhills of the Oconee River opposite Dublin, and on sand-banks along the head-waters of the same river in Middle Georgia (see Bull. Torrey Club **27** : 328. 1900).

Widely distributed in the Eastern United States, but often in unnatural habitats northward.

Root-anatomy studied by W. E. Britton, Bull. Torrey Club **30** : 605. 1903.

CROTALARIA L., Sp. Pl. 714. 1753.

C. rotundifolia (Walt.) Poir., Suppl. **2** : 402. 1811.

Sand-hills, etc.; rather rare. BERRIEN, COLQUITT, THOMAS.

More common in the upper third of the coastal plain, and in Middle Georgia, where it flowers May–September. Also in Glynn County near Brunswick.

Widely distributed in the Southeastern United States, also in Mexico and South America, but not everywhere native.

C. Purshii DC., Prodr. **2** : 124. 1825.

Dry and intermediate pine-barrens; frequent but not abundant. BULLOCH (*857*), TATTNALL, MONTGOMERY, COFFEE, IRWIN, COLQUITT, THOMAS. Fl. May–June. Inland to Sumter County and coastward to Ware.

South Carolina to South Florida and Louisiana, confined to the pine-barrens or nearly so.

BAPTISIA Vent., Dec. Gen. Nov., 9. 1808.

B. perfoliata (L.) R. Br. in Ait. f. Hort. Kew. ed. 2. **3** : 5. 1811. "GOPHER WEED."

Pericaulon perfoliatum Raf., New Fl. N. A. **2** : 51. 1836.

Dry pine-barrens and sand-hills, abundant in the eastern part of our territory. SCREVEN, BULLOCH, EMANUEL, TATTNALL, MONTGOMERY, TELFAIR (eastern part, rare), APPLING (two or three miles north of Baxley only), COFFEE (extreme north-eastern corner). Fl. April–June. Coastward to the upper edge of Bryan County, and inland to the fall-line sand-hills of Georgia and South Carolina. Not definitely known from the intervening Eocene region, or farther west than Telfair County. Why its range is so restricted (much like that of *Elliottia*) is an unsolved problem.

For description of some of its peculiar morphological features see Gray, Am. Jour. Sci. III. **2** : 462. 1871; Ravenel, Proc. A. A. A. S. **20** : 391–393. 1872.

B. lanceolata (Walt.) Ell., Sk. **1** : 467. 1817.

Dry pine-barrens and sand-hills, principally the former. Common in all the pine-barren region of Georgia, and as far inland as Americus. Fl. March–April.

North Carolina to northern Florida and Alabama (Baldwin Co.), in the coastal plain, very nearly confined to the pine-barrens.

B. alba (L.) R. Br. in Ait. f., Hort. Kew. ed. 2. 3:6. 1811.
Dry pine-barrens, etc.; not common. TATTNALL, MONTGOMERY, IRWIN. Fl. April–June. More frequent in the upper third of the coastal plain, and inclined to become a weed.
Minnesota (?) to Florida (?); but distribution not well worked out.

B. leucantha T. & G., Fl. 1:385. 1840.
Swamps of the muddy rivers. MONTGOMERY: Near Mount Vernon; COFFEE: Near Barrow's Bluff. Fl. spring.
Distribution in Georgia and elsewhere not well worked out, but said to be similar to that of the preceding.

GLEDITSCHIA L., Sp. Pl. 1056. 1753.

G. aquatica Marsh., Arb. Am. 54. 1785.
River-swamps. SCREVEN and BULLOCH: Along the Ogeechee River near Dover, June 19, 1901; TATTNALL: Along Ohoopee River near Ohoopee, June 26, 1903. Fl. spring. Also in Laurens County a little north of our limits, and probably in many other places in the upper third of the coastal plain.
Distribution not well worked out; but confined to the coastal plain or nearly so. Reported from South Carolina to Florida, Indiana, Missouri, and Texas, but not from Alabama.

CASSIA L., Sp. Pl. 376. 1753.

C. TORA L., l. c. COFFEE WEED.
Streets of Tifton, Sept. 27, 1902. More common in and around some of the older cities of South Georgia, especially Americus.
Nearly throughout the Southeastern United States. Introduced from the tropics.

C. OCCIDENTALIS L., Sp. Pl. 377. 1753. COFFEE WEED.
With the preceding; also at Faceville, Decatur Co., Aug. 13, 1903. Has about the same distribution in Georgia as well as in other parts of the world.

CERCIS L., Sp. Pl. 374. 1753.

C. Canadensis L., l. c. REDBUD.
Not a characteristic inhabitant of our territory, but growing

only in those exceptional places with rich (perhaps calcareous) soil which constitute considerably less than 1% of the whole area. On wooded bluffs along the muddy rivers in BULLOCH, MONTGOMERY, and WILCOX, also near the Rock House in DOOLY and in the woods where the Lafayette formation seems to be absent (see p. 110) in BERRIEN. Farther south seen in Effingham, Charlton, Brooks, and Thomas Counties. More common in the upper third of the coastal plain, and in Middle and Northwest Georgia, where it flowers in March.

Widely distributed in the Eastern United States between New England and latitude 30°.

MIMOSAEÆ.

MORONGIA Britton, Mem. Torrey Club **5**: 191. 1894.

M. uncinata (Willd.) Britton, l. c.

Dry pine-barrens and sand-hills; not common. BULLOCH, TATTNALL, MONTGOMERY, COFFEE, WILCOX, IRWIN, BERRIEN. Fl. May–June. (Perhaps includes *M. angustata*, which I have never succeeded in distinguishing.) Also in Middle Georgia, and coastward to Cumberland Island; sometimes a weed.

Southeastern United States mostly.

KRAMERIAEÆ.

KRAMERIA Loefl., Iter Hisp. 195. 1758.

? **K. secundiflora** DC., Prodr. **1**: 341. 1824. "SAND-SPUR."

Sand-hills. BULLOCH (*971*), EMANUEL, TATTNALL, MONTGOMERY, TELFAIR, COFFEE, WILCOX. Fl. June–July. Inland to Laurens County and coastward to Bryan. (See Bull. Torrey Club **30**: 336. 1903.)

Also in central and West Florida (but not reported from Alabama). It may well be doubted whether our sand-hill plant is identical with the type of this species, which came from Mexico. The absence of the genus from Alabama (as far as known) is perhaps significant. Its range suggests that of *Frœlichia Floridana* (which see).

ROSACEÆ.

PRUNUS L., Sp. Pl. 473. 1753.

P. Caroliniana (Mill.) Ait., Hort. Kew. **2**: 540. 1789.

EMANUEL: Hammock of Little Ohoopee River, April 5, 1904. Known at a few other points in South Georgia, but so rare that its indigeneity might be questioned. It is commonly cultivated in some of the older cities of the state and readily escapes.

Supposed to be native somewhere in the coastal plain between North Carolina and Texas.

P. serotina Ehrh., Beitr. **3**: 20. 1788. WILD CHERRY.

With the preceding, also near the Ocmulgee River in the northeastern corner of COFFEE County. Very rare in our territory, but increases in abundance toward the mountains. Fl. March–April.

Ranges nearly throughout the Eastern United States, and said to occur also in Mexico and Northwestern South America.

P. ANGUSTIFOLIA Marsh., Arb. Am. 111. 1785. WILD PLUM.
P. Chicasa Mx., Fl. **1**: 284. 1803.

Roadsides, old fields, etc. SCREVEN, BULLOCH, DODGE, COFFEE. Rare in our territory, but common in the older parts of the state.

Scarcely native in Georgia; believed to have been introduced by the aborigines from somewhere westward.

P. umbellata Ell., Sk. **1**: 541. 1821. HOG PLUM.

COFFEE: Woods near the Ocmulgee River opposite Lumber City, Sept. 11, 1903. More common in Middle and Southwest Georgia, both along rivers and as a weed like the preceding. Fl. March–April.

South Carolina to Florida, Missouri, and Louisiana.

CHRYSOBALANUS L.

C. oblongifolius Mx., Fl. **1**: 283. 1803. GROUND OAK.

(Figured without name in Abbot's Georgia Insects, *pl. 68*. 1797.)

Sand-hills and very dry pine-barrens; rather common. Noted

in every county except Screven, Dodge, Worth, and Thomas. Fl. June. Inland to Laurens and Dooly Counties in the Lower Oligocene region, and coastward to Pierce and Charlton in the flat country.

South to central Florida and west to Mississippi, in the pine-barrens.

CRATÆGUS L., Sp. Pl. 475. 1753. "HAW."

C. apiifolia (Marsh.) Mx., Fl. 1 : 287. 1803.

Swamps of rivers rising north of our territory. EMANUEL, TATTNALL, MONTGOMERY, COFFEE. Fl. spring. Grows in similar situations at several other stations in South Georgia. Usually shrubby, rarely if ever a tree.

Virginia to Florida, Missouri, and Texas, chiefly in the coastal plain.

C. æstivalis (Walt.) T. & G., Fl. 1 : 468. 1840. MAY HAW.

C. lucida Ell. not Mill.

TELFAIR: Shallow pond between Scotland and Towns, seen from train Sept. 10, 1903. TATTNALL: Bank of Ohoopee River west of Reidsville (*2160*). Reported from BERRIEN County by the natives. Most frequent in the Lower Oligocene region.

South Carolina (?) to Florida and Texas, in the coastal plain.

C. viridis L., Sp. Pl. 476. 1753.

C. arborescens Ell., Sk. 1 : 550. 1821.

Only in swamps of the muddy rivers. Ogeechee River near Rocky Ford (also near Millen, just north of our territory); Oconee River near Mount Vernon. Fl. March–April. More common in the upper third of the coastal plain, and perhaps also in the Palæozoic region.

North Carolina to northern Florida, Missouri, and Texas.

? **C. Michauxii** Pers. Syn. 2 : 38. 1806.

C. glandulosa Mx., not Ait (?).

SCREVEN: Oak ridge two or three miles west of Sylvania, April 2, 1904. TATTNALL: Sand-hills of Rocky Creek, June 24, 1903. Also in Richmond, Pulaski, and other counties of the coastal plain.

North Carolina to Georgia.

C. uniflora Muench., Hausv. **5**: 147. 1770.

BULLOCH: Sand-hills and dry pine-barrens near Bloys, June, 1901. More common in the upper third of the coastal plain, and in old fields in Middle Georgia.

New Jersey to Florida and Arkansas.

AMELANCHIER Medic., Phil. Bot. **1**: 155. 1789.

A. Canadensis (L.) Medic., Gesch. 79. 1793.

On bluffs and in other places where more or less mesophytic conditions prevail. TATTNALL, MONTGOMERY, COFFEE, WILCOX, DOOLY. Fl. spring. More common farther inland, especially in Middle Georgia, where it flowers in March and April.

Widely distributed in temperate Eastern North America.

A. sp. (See Bull. Torrey Club **33**: 237. 1906.)

EMANUEL: Sandy bog in pine-barrens near Graymont, June 6, 1901 (*819*). Also in Richmond County.

ARONIA Medic.

A. arbutifolia (L.) Pers.

Mostly in branch-swamps; frequent. BULLOCH, EMANUEL, MONTGOMERY, TELFAIR, COFFEE, WILCOX, IRWIN, BERRIEN, COLQUITT, THOMAS, DECATUR. Fl. March-April. Also coastward to Camden County. Like *Viburnum nudum*, with which it commonly associates, it is rare or absent in the Lower Oligocene region of Georgia, but reappears in the Eocene region and in a few moist sandy places in Middle Georgia.

Newfoundland to Minnesota in the glaciated region, south to Florida, Arkansas, and Louisiana in the coastal plain. Rare in the intervening highlands. (See Rhodora **7**: 74. 1905.)

Leaf-anatomy discussed by W. E. Britton, Bull. Torrey Club **30**: 595. 1903.

AGRIMONIA L., Sp. Pl. 448. 1753.

A sp.

DOOLY: Around lime-sink east of Wenona, Sept. 1, 1903 (*1961*). Does not strictly belong to our flora, but rather to that of the upper third of the coastal plain.

RUBUS L., Sp. Pl. 492. 1753.

R. CUNEIFOLIUS Pursh, Fl. 1:347. 1814. "BRIER-BERRY."

Roadsides, old fields, etc., and perhaps sometimes in dry pine-barrens. BULLOCH, DODGE, WILCOX, IRWIN, BERRIEN, COLQUITT, and probably all other South Georgia counties. Fl. spring.

Connecticut to Florida, Missouri, and Louisiana, mostly in the coastal plain, but natural range and habitat uncertain.

R. Nigrobaccus Bailey, Ev. Nat. Fr. 306, 370, 379. *f. 59, 60.* 1898. BLACKBERRY.

Damp woods and swamps, apparently only where the Lafayette formation is thin or absent. COFFEE, BERRIEN. Also in similar situations in Camden County and elsewhere in South Georgia.

Owing to uncertainty of specific limits in this genus the range of this cannot be given satisfactorily.

R. Trivialis Mx., Fl. 1:296. 1803. DEWBERRY.

Dry pine-barrens, or perhaps oftener a weed. SCREVEN, EMANUEL, BULLOCH. Fl. spring. Common in old fields in Middle Georgia.

Widely distributed in the Southeastern United States, but natural range and habitat uncertain.

HAMAMELIDACEÆ.

LIQUIDAMBAR L., Sp. Pl. 999. 1753.

L. Styraciflua L., l. c. "SWEET GUM."

Common in river-swamps and on bluffs and rock outcrops, also often in moist pine-barrens, where it is only a shrub (and apparently sterile). Fl. March. Grows all over the state, reaching its best development north of our territory, in swamps or alluvial bottoms.

Common from Connecticut to Missouri, Florida, and Texas. Also in Mexico and Central America, if it is all the same species.

Leaf-anatomy studied by Kearney, Contr. U. S. Nat. Herbs 5:490. 1901. For a discussion of some other properties of this species see Bull. 58, U. S. Bureau of Forestry.

HAMAMELIS L., Sp. Pl. 124. 1753.

H. Virginiana L., l. c. WITCH HAZEL.

Hammocks, bluffs, etc.; frequent. BULLOCH, EMANUEL, TATTNALL, MONTGOMERY, DODGE, TELFAIR, COFFEE, WILCOX, BERRIEN, DOOLY. Widely distributed over the state, more common farther inland. Flowers from October to January in Middle Georgia.

Throughout the Eastern United States north of latitude 30°.

SAXIFRAGACEÆ.

ITEA L., Sp. Pl. 199. 1753.

I. Virginica L., l. c.

Chiefly in creek-swamps. BULLOCH, MONTGOMERY, COFFEE, BERRIEN, COLQUITT. Fl. June–April. Coastward to Camden County, and inland at least to Athens in Middle Georgia.

New Jersey to South Florida and Arkansas, most abundant in the coastal plain.

Leaf-anatomy studied by Kearney, Contr. U. S. Nat. Herb. **5**: 490–491. 1901.

DECUMARIA L., Sp. Pl. ed. 2. 1663. 1763.

D. barbara L., l. c.

Only in the peculiar low woods already mentioned (see p. 110), west and southwest of Tifton, BERRIEN Co., September, 1902. Also in Camden County, but more common farther inland, at least as far north as Northwest Georgia, but perhaps not in the mountains. Fl. May.

Virginia to Florida and Louisiana.

Leaf-anatomy studied by Kearney, Contr. U. S. Nat. Herb. **5**: 491. 1901.

SARRACENIACEÆ.

SARRACENIA L., Sp. Pl. 510. 1753. PITCHER PLANTS.

S. minor Walt., Fl. Car. 153. 1788.

S. variolaris Mx. Fl. **1**: 310. 1803. (See Bull. Torrey Club **30**: 331–332. 1903.)

Moist and intermediate pine-barrens; common (but not as abundant as the next) in every county except Decatur.

Fl. April–May. Also in every county in the flat country, and inland to Johnson, Sumter, and Early Counties in the Lower Oligocene region.

North Carolina to central and Middle Florida, strictly confined to the pine-barrens.

S. **flava** L., l. c. "PITCHERS."

Probably the most abundant and conspicuous herb in our moist pine-barrens. Much more rarely in branch-swamps and shallow ponds. Noted in every county in our territory except Laurens and Decatur (see plate XXIII). Its inland limit coincides very closely with the Altamaha Grit escarpment, not extending beyond it more than a mile or two, if at all (see Bull. Torrey Club **32** : 147. 1905). Fl. April. Toward the coast it extends only to Effingham, Wayne, Pierce, Ware, Lowndes, and Brooks Counties in the flat country. In other states its range is not so restricted, for it has been found above the fall-line in Virginia and North Carolina (see Torreya **3** : 123–124. 1903).

Dinwiddie County, Virginia (see Torreya **4** : 123. 1904), to northern Florida and Alabama, mostly in the coastal plain. Also in western North Carolina (*Small & Heller.*)

S. **rubra** Walt., Fl. Car. 152. 1788.

Sand-hill bogs and moist pine-barrens; rather rare. BULLOCH, EMANUEL (*810*), TATTNALL (*2147*), MONTGOMERY (*1871*). Fl. April. Known otherwise in the state only from Richmond and Sumter Counties (see Bull. Torrey Club **27** : 428. 1900; **30** : 334. 1903).

North Carolina to West Florida and Mississippi, mostly in the coastal plain.

S. **psittacina** Mx., Fl. **1** : 311. 1803; Croom, Ann. Lyc. N. Y. **4** : 101. 1837.

S. calceolata Nutt., Trans. Am. Phil. Soc. **4** : 49. *pl. 1.* 1833.

S. pulchella Croom, Am. Jour. Sci. **25** : 75. 1833.

Moist pine-barrens, from BULLOCH to COLQUITT, inland to WILCOX, and coastward to Charlton County. Abundant but inconspicuous; usually with *S. minor* or *S. flava* or both of them. Fl. April. Never seen northwest of the Altamaha

Grit escarpment. (Michaux reported it from Augusta, but that is almost certainly an error, as the plant has not been seen within 60 miles of there since Michaux's time.)

South to Florida and west to Louisiana, in the pine-barrens.

S. purpurea L., Sp. Pl. 510. 1753.

TATTNALL: Sand-hill bog near Reidsville, April 26, 1904, past flowering (*2151*). Known from only one or two other stations in Georgia (see Bull. Torrey Club **31**: 23. 1904).

Ranges throughout the glaciated region of the northern states and adjacent Canada, and in the coastal plain from North Carolina to Middle Florida and West Tennessee, but absent from most of the intervening territory (see Rhodora **7**: 74. 1905).

The following natural hybrids have been noticed in our territory, each in moist pine-barrens in company with both parents.

S. flava × minor Harper, Bull. Torrey Club **30**: 332. 1903. **31**: 22. 1904. **32**: 462. *f. 4.* 1905. (See plate XXIV, fig. 1, and plate XXV, fig. 2).

BULLOCH (*855*), COFFEE (*1437*).

Also reported from South Carolina (Macfarlane, Trans. & Proc. Bot. Soc. Pa. **1**: 430. 1904).

S. minor × psittacina Harper, Bull. Torrey Club **33**:

COFFEE, WILCOX, IRWIN (*2211*), COLQUITT.

Not known elsewhere.

DROSERACEÆ.

DROSERA L., Sp. Pl. 281. 1753.

D. filiformis Raf., Med. Rep. II. **5**: 360. 1808.

COLQUITT: Abundant in moist pine-barrens at several stations within a few miles of Moultrie (*1645*) and Autreyville. Not seen in flower or fruit. Also occurs in Thomas County, a little south of our limits, but not known in other parts of the state.

Massachusetts to Delaware, and Georgia to West Florida and Mississippi, in the coastal plain; but there seem to be some considerable gaps in its range; or perhaps the northern and southern plants are not identical.

? **D. capillaris** Poir., Encyc. **6**: 299. 1804.

Moist pine-barrens; common but inconspicuous. Probably grows in every county in the region, but only noted in BULLOCH, MONTGOMERY, DODGE, TELFAIR, COFFEE, WILCOX, IRWIN, BERRIEN, COLQUITT, and DECATUR. Fl. June–Aug. Ranges nearly throughout South Georgia, wherever the Columbia sand occurs.

Our plant does not agree exactly with published descriptions of *D. capillaris*, and might just about as well be *D. brevifolia* Pursh. These two species are said to range from North Carolina to Florida and Louisiana in the coastal plain.

The fact that the whole foliage of this plant (whichever species it may be) is red is rarely if ever mentioned in descriptions.

CAPPARIDACEÆ.

ALDENELLA Greene, Pittonia 4: 212. 1900.

A. tenuifolia (LeConte) Greene, l. c.

Polanisia tenuifolia (LeConte) T. &. G., Fl. **1**: 123. 1838.

Sand-hills and sand-hammocks; rather rare. TATTNALL (*1861*), MONTGOMERY. Fl. June–Aug. Also in Liberty, McIntosh, Wayne, and Pierce Counties in the flat country.

Reported also from Florida and southeastern Alabama.

CRUCIFERÆ.

WAREA Nutt., Jour. Acad. Phila. 7: 83. 1834.

W. cuneifolia (Muhl.) Nutt., l. c. 84.

Cleome cuneifolia Muhl.; Nutt. Gen. **2**: 73. 1818.

Stanleya gracilis DC., Syst. **2**: 512. 1821.

Sand-hills, particularly toward the hammocks at their bases; sometimes with the preceding, and almost as rare. MONTGOMERY (*1981*), TELFAIR, COFFEE. Fl. July–Sept. Also in Richmond (*A. Cuthbert*) and Pierce Counties. Found by Elliott on the fall-line sand-hills somewhere between Milledgeville and Columbus.

South Carolina (*Bartram*, according to DeCandolle) to South Florida, in the coastal plain.

This, the only native crucifer in our flora, has considerable affinity with the preceding family, as was noticed by Nuttall

when he described it. The similarity of its habitat to that of the preceding species is probably not without significance.

LEPIDIUM L., Sp. Pl. 643. 1753.

L. VIRGINICUM L., Sp. Pl. 645. 1753. PEPPERGRASS.

A weed in the streets of Collins, Fitzgerald, Tifton, Nashville, and doubtless other places. More common farther inland.

Widely scattered from Canada to Central America, but natural range and habitat unknown.

CORONOPUS Gaert., Fr. & Sem. 2 : 293. 1791.

C. DIDYMUS (L.) J. E. Smith, Fl. Brit. 3 : 691. 1800.

Streets of Swainsboro, April 6, 1904. More common in older cities.

Canada to Brazil; also in Europe. Natural range and habitat unknown.

PAPAVERACEÆ.

SANGUINARIA L., Sp. Pl. 505. 1753.

S. Canadensis L., l. c. (BLOODROOT.)

WILCOX: Upper Seven Bluffs on the Ocmulgee River, May 17, 1904. Not properly belonging to our flora. More common in the upper third of the coastal plain and farther inland, ranging northward to Canada.

The Wilcox County plant is probably identical with a specimen from Sumter County, without flowers or fruit, which was made by Prof. Greene the type of his *S. rotundifolia* (Pittonia 5 : 308. 1905). It does not seem best to take up Prof. Greene's species until more is known about it, however.

BERBERIDACEÆ.

PODOPHYLLUM L., Sp. Pl. 505. 1753.

P. peltatum L., l. c. (MAY APPLE.)

BULLOCH: Wooded bluff along Ogeechee River near Echo, March 31, and April 4, 1904, in flower (*2079*). Like the preceding, this does not properly belong to our flora, but is more common in the older parts of the country. It is nowhere abundant in Georgia.

Ranges northward to Canada.

Anatomy described by Holm, Bot. Gaz. **27**: 419–433. *f. 1–10.* 1899.

NYMPHÆACEÆ.

CASTALIA Sal., in Koenig & Sims, Ann. Bot. **2**:71. 1805.

C. odorata (Dryand.) Woodv. & Wood in Rees Cycl. **6**:—. 1808. WATER LILY.

Not a typical member of our flora, because it seems to require permanent stagnant water. Grows in a pine-barren pond near the Altamaha Grit escarpment in SCREVEN, and in an artificial pond (Heard's Pond) just within our southern border in THOMAS. Fl. April–Aug.

Widely distributed in the glaciated region and coastal plain of the Eastern United States, but mostly wanting in the Piedmont region and mountains, or if occurring there probably introduced. (See Rhodora **7**:78. 1905.)

NYMPHÆA L., Sp. Pl. 510. 1753.

N. fluviatilis Harper, Bull. Torrey Club **33**:234–236, *f.2*, 1906. "BONNETS."

In slow-flowing water in small rivers and in swamps of the larger rivers. In the Ogeechee near Rocky Ford and Dover (also at several points north of our territory), in the Ohoopee near Ohoopee and Reidsville, in the Oconee swamps near Mount Vernon, in the Little Ocmulgee near Lumber City, and in the Withlacoochee near Nashville. Flowers in June, and doubtless also somewhat earlier and later. Pretty widely distributed in South Georgia, from Glascock and Crawford Counties to McIntosh, but not yet known in other states (see original description).

N. ORBICULATA Small. Bull. Torrey Club **23**:128. 1896.

Known in our territory only from Heard's Pond in THOMAS County, an artificial pond made by damming up an ordinary branch-swamp. (*1178*). This happens to be the type-locality, but the species is evidently not native there. (See Bull. Torrey Club **30**:331; **32**:146. Rhodora **7**:78.) It is native however not far away, in the large lime-sink ponds of Decatur and Lowndes Counties (see Bull. Torrey Club **30**:331 and errata. 1903; **31**:14. 1904), and adjacent Florida.

BRASENIA Schreb.

B. purpurea (Mx.) Caspary.

Like *Castalia*, this does not properly belong to our flora. It grows in ponds along the escarpment in SCREVEN and WILCOX, and adventive in Heard's Pond, THOMAS County, with the preceding, and in accidental ponds (caused by building a railroad embankment across branches without allowing any outlet) in the northern corner of TELFAIR and adjacent portions of DODGE. Fl. May–June.

General distribution in North America about the same as that of *Castalia odorata*. Said to grow also in Cuba, Central America, Asia, Africa, and Australia, but probably it is not native in all that territory, or else there is more than one species involved. The same or a related species has been found fossil in Europe.

MAGNOLIACEÆ.

LIRIODENDRON L., Sp. Pl. 535. 1753.

L. Tulipifera L., l. c. (TULIP TREE.) "POPLAR."

Chiefly in branch-swamps, frequent throughout. Apparently a little more abundant in COLQUITT than in any other county in our region. Fl. April. Probably grows in every county in Georgia, reaching its best development in mountain valleys.

Ranges throughout the Eastern United States between latitudes 30° and 42°.

MAGNOLIA L., Sp. Pl. 535. 1753.

M. grandiflora L., Syst. ed. 10. **2**: 1082. 1759. "MAGNOLIA"[1] "LOBLOLLY."

Hammocks, bluffs, Altamaha Grit escarpment, etc.; frequent but not abundant. EMANUEL, TATTNALL (*1862*), MONTGOMERY, DODGE, TELFAIR, COFFEE, WILCOX, BERRIEN, DOOLY, WORTH, THOMAS, DECATUR, and doubtless in the remaining counties as well. (Magnolia P. O. in Mitchell County, which seems to be on or near the escarpment, is in all probability named

[1] How the technical name *Magnolia* could have penetrated to some of the remotest rural districts is a problem for the philologist.

for this tree.) Fl. May–June. Widely distributed over South Georgia up to within about ten miles of the fall-line. (See in this connection Croom, Am. Jour. Sci. **25**: 314–315. 1834.)

North Carolina to central Florida, Arkansas, and Texas, strictly confined to the coastal plain.

M. glauca L., Sp. Pl. ed. 2, 755. 1763. "BAY." "WHITE BAY."

A small tree in branch-swamps, very common. Also in non-alluvial creek-swamps one of our largest trees (2½ by 80 feet in COFFEE County), and in wet pine-barrens often abundant as a knee-high shrub,[1] flowering and fruiting freely. Noted in every county except Laurens and Mitchell (but my work in the portions of those counties included in this flora has been confined to about five miles of car-window observations in each case). Fl. April–July. Ranges throughout South Georgia, and inland to Carroll County in western Middle Georgia, where it reaches a considerable size. Abundant in Chattahoochee County, in the Cretaceous region.

Massachusetts (one station, doubtfully native), Long Island (rare) and eastern Pennsylvania to central Florida, Arkansas and Texas, mostly in the coastal plain.

Leaf-anatomy described by Kearney, Contr. U. S. Nat. Herb. **5**: 488–489. 1901.

ANONACEÆ.

ASIMINA Adans., Fam. **2**: 365. 1763. PAWPAW.

A. parviflora (Mx.) Dunal, Monog. Anon. 82. *pl. 9.* 1817.

Hammocks, bluffs, etc. EMANUEL, TATTNALL, MONTGOMERY, TELFAIR, COFFEE, WILCOX, BERRIEN. Fl. March–April. Widely distributed in Middle and South Georgia.

North Carolina to central Florida and Mississippi (?), in the Piedmont region and coastal plain.

A. speciosa Nash, Bull. Torrey Club **23**: 238. 1896.

Only south of the Altamaha River, in dry pine-barrens, sand-hills, etc. APPLING, COFFEE (*1438*), and the northeastern

[1]A similar form has been noted by Dr. Hilgard in Jackson County, Mississippi (Geol. and Agric. Miss., p. 368. §816. 1860.)

corner of BERRIEN. Fl. April–May. Also coastward in Pierce, Charlton, and Camden Counties, and reported from adjacent Florida.

A. angustifolia Gray, Bot. Gaz. 11 : 163. 1886.

Dry pine-barrens and sand-hills; not common. TATTNALL, MONTGOMERY, COFFEE, WILCOX, BERRIEN, COLQUITT. Fl. May. Inland to Lee, Early, and Decatur Counties in the Lower Oligocene region (especially common around Bainbridge), and coastward to Cumberland Island and adjacent Florida.

RANUNCULACEÆ.

Represented by only three species, none of them common.

THALICTRUM L., Sp. Pl. 545. 1753.

T. macrostylum (Shuttl) Small & Heller, Mem. Torrey Club 3^1: 8. 1892.

MONTGOMERY: Bluff along Oconee River near Ochwalkee, July 1, 1903 (*1867*). More frequent in the lime-sink region.

Western North Carolina to Middle Florida.

CLEMATIS L., Sp. Pl. 543. 1753.

C. reticulata Walt., Fl. Car. 156. 1788.

COFFEE: Lower slopes of sand-hills of Seventeen Mile Creek near Douglas, July 30, 1902. (*1463*). Also known farther inland, in Sumter and Marion Counties.

South Carolina to Florida, Arkansas, and Texas, in the coastal plain.

C. crispa L., l. c.

Swamps; rare. TATTNALL: Along Ohoopee River; COLQUITT: Branch-swamp near Moultrie. Fl. spring and summer.

Widely distributed in the Southeastern United States.

CARYOPHYLLACEÆ.

ARENARIA L., Sp. Pl. 423. 1753.

A. Caroliniana Walt., Fl. Car. 141. 1788.

A. squarrosa Mx., Fl. 1 : 273. 1873.

On sand-hills; not rare in the eastern part of our territory.

BULLOCH (*911*), EMANUEL, TATTNALL, COFFEE. Fl. April–June. Extends inland to the fall-line in Richmond County and coastward to Bryan County.

Long Island to West Florida, in the coastal plain.

A. brevifolia Nutt.; T. & G., Fl. 1 : 180. 1838.

TATTNALL: Flat rocks near Ohoopee River (*2157*). Fl. early spring. This is supposed to be the type-locality, or very near it (see Torreya **4** : 138–141. 1904). Known elsewhere in the state only from granite outcrops in Middle Georgia, where it is quite abundant in spots.

Occurs also in the upper parts of North Carolina and Alabama.

SAGINA L., Sp. Pl. 128. 1753.

S. DECUMBENS (Ell.) T. & G., Fl. 1 : 177. 1838.

A weed. Lulaville, May 17, 1904. More common in the older-settled parts of the state.

Widely distributed in the Eastern United States south of latitude 41°, but natural range and habitat unknown.

STIPULICIDA Mx., Fl. 1 : 26. 1803.

S. setacea Mx., l. c. *pl. 6.*

Sand-hills, etc.; rather common. BULLOCH, EMANUEL, TATTNALL, MONTGOMERY, DODGE, TELFAIR, COFFEE, WILCOX, BERRIEN, COLQUITT. Fl. April–July, if not later. Less common in other parts of South Georgia.

North Carolina to Florida and Mississippi, in the coastal plain.

PORTULACACEÆ.

PORTULACA L., Sp. Pl. 445. 1753.

P. PILOSA L., l. c.

A weed, mostly around dwellings; not common. TELFAIR, COFFEE, COLQUITT. Not noticed farther north.

Doubtless introduced from the tropics.

TALINUM Adans., Fam. 2 : 245. 1763.

T. teretifolium Pursh, Fl. 365. 1814.

Figured in Meehan's Native Flowers & Ferns 2 : 53-56. *pl. 14.* 1879.

Rock outcrops. TATTNALL (*1859*), DOOLY. (See Bull. Torrey

Club **32**: 143, 160. *f. 1.* 1905. The illustration in Torreya 4: 140 represents another station for it.) Known elsewhere in the state only on flat granite rocks in Middle Georgia, where it flowers from May to September.

New York to Alabama, mostly in the Piedmont region.

AIZOACEÆ.

MOLLUGO L., Sp. Pl. 89. 1753.

M. VERTICILLATA L., l. c.

WILCOX: Near dwelling, Queensland, May 17, 1904. More common in the older-settled parts of the state.

Widely distributed in North and South America, but natural range and habitat unknown.

NYCTAGINACEÆ.

BOERHAVIA L., Sp. Pl. 3. 1753.

B. ERECTA L., l. c.

A weed in Tifton, Sept. 27, 1902. More common in larger and older cities in other parts of the state (*e. g.*, Athens, Americus, Brunswick). Fl. June–Oct.

South Carolina to Mexico and the West Indies. Certainly not native in Georgia, and probably introduced from the tropics.

ILLECEBRACEÆ.

GIBBESIA Small, Bull. Torrey Club 25: 621. 1898.

G. Rugelii (Shuttl.) Small, l. c.

MONTGOMERY: Lower slopes of sand-hills of Little Ocmulgee River, Sept. 10, 1903. (*1990*). Fl. Aug.–Sept. Known otherwise only from the lime-sink regions of Decatur and Lowndes Counties, and a few places in Florida.

SIPHONYCHIA T. & G., Fl. 1: 172. 1838.

S. Americana (Nutt.) T. & G., Fl. 1: 173. 1838.

Sand-hills; not common. COFFEE (*700*), IRWIN, BERRIEN 1696). Fl. Sept–Oct. Inland to Richmond County (*A. Cuthbert*).

South Carolina to Florida, in the pine-barrens, with the above exception.

S. pauciflora Small., Fl. 402. 1903.

Hammocks and sand-hills. Perhaps intergrades with the

preceding. BULLOCH (*967*, type), DODGE, TELFAIR, COFFEE. Fl. June–Sept. Extends inland to the vicinity of Augusta (*A. Cuthbert*) and Dublin.

Also in Florida.

PARONYCHIA Adans., Fam. **2** : 272. 1763.

P. herniarioides (Mx.) Nutt.; Spreng., Syst. **1** :822. 1825.

Sand-hills and sand-hammocks. BULLOCH (*912*), EMANUEL (*978*), TATTNALL, MONTGOMERY, COFFEE, WILCOX. (See Bull. Torrey Club **30**: 328. 1903.) Inland to Taylor (*H. M. Neisler*) and Pulaski Counties and coastward to Bryan.

North Carolina to central Florida, in the coastal plain.

P. riparia Chapm., Fl. ed. 2,607. 1883.

Hammocks, sand-hammocks, and sandy river-banks. EMANUEL, TATTNALL, MONTGOMERY (*1869*), TELFAIR, COFFEE. Extends inland to several points along and near the Flint River in the lime-sink region, and coastward down the Altamaha River to McIntosh County.

Not definitely known outside of South Georgia.

AMARANTHACEÆ.

FRŒLICHIA Moench, Meth. 50. 1794.

F. Floridana (Nutt.) Moq. in DC. Prodr. **13**[2] : 420. 1849.

MONTGOMERY: Sand-hills and hammock of Gum Swamp Creek and Little Ocmulgee River, Sept. 10, 1903; a little past flowering. Also occurs in sandy soil in Richmond, Sumter, TELFAIR, Liberty, and Charlton Counties, but apparently there only as a weed.

Reported also from several places in Florida and one in Alabama, but whether native or not cannot be ascertained at present. Material from the Great Plains region formerly referred to this has been made the type of a new species (*F. campestris*) by Dr. Small.

ALTERNANTHERA R. Br., Prodr. Fl. Nov. Holl. 416. 1810.

A. REPENS (L.) Kuntze, Rev. **2** : 536. 1891.

A. Archyrantha (L.)

A weed along streets and near dwellings. In Helena and at

a farmhouse about five miles north of Whigham. More common nearer the coast, in Savannah, Brunswick, and Thomasville.

Widely distributed in the tropics, and naturalized along the southern coasts of the United States.

CHENOPODIACEÆ.

CHENOPODIUM L., Sp. Pl. 218. 1753.

C. AMBROSIOIDES L. (or perhaps *C. anthelminticum* L.)

Streets of Tifton, Sept. 27, 1902. Common in older communities.

Introduced from the tropics.

POLYGONACEÆ.

ERIOGONUM Mx., Fl. 1: 246. 1803.

E. tomentosum Mx., l.c., *pl. 24*.

Sand-hills and very dry pine-barrens; common throughout South Georgia, where the Columbia sand is present (see Science, II. **16**: 68. 1902), from the fall-line to within about 20 miles of the coast along the Altamaha River. Fl. July–Sept. One can hardly imagine a Georgia sand-hill without this plant on it.

South Carolina to central Florida and southeastern Alabama, strictly confined to the coastal plain.

RUMEX L., Sp. Pl. 333. 1753.

R. HASTATULUS Baldw.; Ell., Sk. 1: 416. 1817.

Fields and roadsides; often with *Linaria Canadensis*. BULLOCH, EMANUEL, and probably other counties. Fl. April–May.

New York to Florida, Texas, and Kansas, mostly in the coastal plain. Natural range and habitat unknown.

POLYGONELLA Mx., Fl. 2: 240. 1803.

P. Croomii Chapm., Fl. 387. 1860.

Sand-hills. A diminutive diffusely-branched shrub. EMANUEL, TATTNALL, MONTGOMERY (*1985*). Fl. September, and perhaps later.

Not definitely known elsewhere. See Bull. Torrey Club **32**: 159–160. 1905.

P. gracilis (Nutt.) Meisn., in DC. Prodr. **14**:80. 1856.

Sand-hills. DODGE (*1977*), MONTGOMERY, and doubtless elsewhere. In COFFEE County I have collected a form (*2010*) with linear acute leaves, but apparently otherwise identical. Fl. September. Coastward to McIntosh County.

South Carolina to Florida and Mississippi, in the pine-barrens.

THYSANELLA Gray, Bost. Jour. Nat. Hist. **5**:24. 1845.

T. fimbriata (Ell.) Gray, l. c. (excl descr.).

Sand-hills. TATTNALL, MONTGOMERY, COFFEE, WILCOX, BERRIEN (*1694*). Fl. Sept.–Oct. Extends inland to the fall-line sand-hills in Taylor County, where Elliott discovered it (see Bull. Torrey Club **31**:12. 1904), and coastward to Bryan County.

Also in Florida and southeastern Alabama.

BRUNNICHIA Banks; Gaert., Fr. & Sem. **1**:213. *pl. 45. f. 2.* 1788.

B. cirrhosa Banks, l. c.

Swamps of the muddy rivers. Oconee River near Mount Vernon, and Ocmulgee River near Lumber City. Fl. July–Aug. Extends down the Altamaha to Doctortown and Barrington, but more frequent along the Flint and Chattahoochee Rivers in the upper third of the coastal plain.

South Carolina to Florida (River Junction), Illinois, and Arkansas, in the coastal plain.

ARISTOLOCHIACEÆ.

ARISTOLOCHIA L., Sp. Pl. 960. 1753.

A. Serpentaria L., Sp. Pl. 961. 1753.

WILCOX: Upper Seven Bluffs, May 17, 1904. Does not properly belong to our flora, but is more common in the upper third of the coastal plain and northward to the mountains and beyond, much as in the case of *Sanguinaria* and *Podophyllum*, already mentioned.

Connecticut to Michigan, northern Florida, and Missouri.

LORANTHACEÆ.

PHORADENDRON Nutt., Jour. Acad. Phila. II. **1**:185. 1848.

P. flavescens (Pursh) Nutt.; Gray, Man. ed. 2, 383, 1856. "MISTLETOE."

In our territory its usual host is *Nyssa biflora*, and it grows wherever that does, in swamps and ponds. SCREVEN, BULLOCH, TATTNALL, MONTGOMERY, COFFEE, WILCOX, IRWIN, BERRIEN, DOOLY. Distributed nearly all over Georgia.

Widely distributed in the Eastern United States south of the glaciated region.

Leaf-anatomy described by Kearney, Contr. U. S. Nat. Herb. 5 : 487. 1901.

MORACEÆ.

MORUS L., Sp. Pl. 986. 1753.

M. rubra L., l. c. MULBERRY.

In our territory only where the Lafayette formation seems to be absent, in rich or slightly calcareous soil. MONTGOMERY: Stallings' Bluff; BERRIEN: Woods west of Tifton (see p. 110); DOOLY: Around the Rock House. Fl. spring. More common farther inland, particularly in the Palæozoic region (Northwest Georgia).

Widely distributed in the Eastern United States.

ULMACEÆ.

ULMUS L., Sp. Pl. 225. 1753. ELM.

U. alata Mx., Fl. 1 : 173. 1803.

DOOLY: In lime-sink between Wenona and the Rock House, near the Altamaha Grit escarpment, Sept. 1, 1903 (*1963*). A large tree. More common farther inland, like most other species growing along the escarpment.

Widely distributed in the Southeastern United States.

What is probably another species grows in some of the muddy river-swamps.

PLANERA Gmel., Syst. 2 : 150. 1791.

P. aquatica (Walt) Gmel., l. c. HORNBEAM. (WATER) ELM.

River-swamps. SCREVEN, BULLOCH (*2080*), TATTNALL, MONTGOMERY, COFFEE. Fl. Feb.–March. Pretty widely distributed in South Georgia, from Crawford and Wilkinson Counties to McIntosh and Clinch.

North Carolina to Florida, Illinois, and Texas, in the coastal plain.

CUPULIFERÆ.

QUERCUS L., Sp. Pl. 994. 1753. OAKS.

Q. alba L., Sp. Pl. 996. 1753. WHITE OAK.

Rather rare in our territory. Usually on bluffs with *Polystichum acrostichoides* (see Fern Bull. **13** : 13. 1905). MONTGOMERY: Along Oconee River near Mount Vernon and Ochwalkee; COFFEE: Barrow's Bluff; DOOLY: Around the Rock House. More common farther inland, particularly toward the mountains.

Throughout the Eastern United States north of latitude 29°.

Q. minor [Marsh.] Sarg., Gard. & For. **2** : 471. 1889. POST OAK.

MONTGOMERY: Stallings' Bluff, June 29, 1903. More common farther inland, like the preceding, and having nearly the same range.

Q. Margaretta Ashe. "POST OAK."

Sand-hills, oak ridges, etc.; common. Ranges nearly all over South Georgia.

North Carolina to Florida and Alabama, in the coastal plain.

Q. lyrata Walt., Fl. Car. 235. 1788. (POST OAK.)

Only in swamps of rivers which rise north of our territory; usually with *Ilex decidua*. BULLOCH: Ogeechee River; EMANUEL: Little Ohoopee River; MONTGOMERY: Oconee River; TELFAIR: Ocmulgee River. More common in the upper third of the coastal plain. Extends sparingly inland to Columbia, Gwinnett (*Small*), and Carroll Counties, and down the Altamaha to McIntosh.

North Carolina to Florida (?), Missouri, and Texas, mostly in the coastal plain.

Q. Michauxii Nutt., Gen. **2** : 215. 1818.

Noted in our territory at each of the same places as the preceding, and on the same dates. Its general distribution in Georgia and elsewhere is much the same, except that it seems to range a little farther north.

Q. geminata Small, Bull. Torrey Club **24** : 438. 1897. "LIVE OAK."

Sand-hills, hammocks, etc. Noted at several stations in

TATTNALL, COFFEE (*2050*), and BERRIEN. Doubtless grows in some of the other counties, but probably not in all, as it seems to be confined to the lower half of the coastal plain, like *Cholisma ferruginea*, *Castanea alnifolia*, and *Serenoa*. Fl. April. In COFFEE County it becomes as much as two feet in diameter, and thirty feet tall. Its trunk is ascending or curved, never strictly erect.

Ranges mostly southward, but distribution not well worked out. Until recently confused with *Q. Virginiana*. (See Bull. Torrey Club **32** :465. 1905.)

Q. pumila Walt., Fl. Car. 234. 1788. "OAK RUNNER"

Intermediate and dry pine-barrens; not rare. SCREVEN (*2089*), BULLOCH (*905*), TATTNALL, TELFAIR, APPLING, COFFEE (*1457*), IRWIN, BERRIEN, WORTH, COLQUITT, DECATUR. Fl. March. Common toward the coast, but apparently wanting in the upper third of the coastal plain.

North Carolina to Florida, in the pine-barrens.

Q. digitata [Marsh.] Sudw., Gard. & For. **5**:98,99. 1892. (SPANISH OAK.) "RED OAK."

Dry pine-barrens. Noted only in COFFEE County, but doubtless occurs elsewhere in the region, where the Columbia formation is thin or absent. Common farther inland, especially in Middle Georgia.

Widely distributed in the Southeastern United States north of latitude 30°.

Q. Catesbæi Mx., Hist. Chen. Am. *pl. 29, 30*. 1801. "BLACK JACK." "TURKEY OAK."

On every sand-hill, and in dry pine-barrens; abundant throughout. Fl. March. Pretty widely distributed in South Georgia, and seen also on the rocky slopes of the Pine Mountains (see Bull. Torrey Club **30** : 294. 1903). Usually a small tree trunk rarely over a foot in diameter.

North Carolina to central Florida and Louisiana, in the coastal plain (with the exception above noted).

Q. Marylandica Muench., Hausv. **5** :253. 1770. "DOLLAR-LEAF OAK." "BLACK JACK."

Dry pine-barrens, where the Lafayette loam is at or near the

surface. SCREVEN, BULLOCH, EMANUEL, TATTNALL, MONTGOMERY, APPLING, COFFEE, WILCOX, DOOLY, DECATUR. More common farther inland, particularly in Middle Georgia.
Widely distributed in the Eastern United States south of latitude 41°.

Q. nigra L., Sp. Pl. 995. 1753. (in part.) "WATER OAK."
Q. aquatica [Lam.] Walt., Fl. Car. 234. 1788.
Chiefly in creek-swamps with *Acer rubrum;* not very common. SCREVEN, EMANUEL, TATTNALL, BERRIEN, DOOLY, COLQUITT, THOMAS. More common in the upper third of the coastal plain, and in Middle Georgia.
Widely distributed in the Eastern United States south of latitude 39°.

Q. brevifolia [Lam.] Sarg., Silva **8** : 171. *pl. 431.* 1893.
Q. cinerea Mx. "TURKEY OAK" (HIGH-GROUND WILLOW OAK).
Sand-hills and dry pine-barrens throughout, usually with *Q. Catesbæi* and almost as common. A small tree, rarely a foot in diameter. Ranges from the fall-line sand-hills al most to the coast.
North Carolina to central Florida and Texas, in the coastal plain.

Q. laurifolia Mx., Hist. Chen. Am. *pl. 17.* 1801. "WATER OAK."
The prevailing oak in hammocks and allied habitats SCREVEN, EMANUEL, TATTNALL, MONTGOMERY, DODGE, COFFEE, WILCOX, BERRIEN. Pretty widely distributed in South Georgia. Differs from its nearest relatives in being evergreen, like most hammock trees, and therefore unmistakable in winter.
Virginia to central Florida and Louisiana, in the coastal plain.
Leaf-anatomy discussed by Kearney, Contr. U. S. Nat. Herb. **5** : 295. 1900. Both Kearney and Small speak of this species as deciduous, but it is decidedly evergreen in Georgia, and Croom found it so in North Carolina (Cat. Pl. Newbern, 47. 1837.)

Q. Phellos L., Sp. Pl. 994. 1753. WILLOW OAK.
Ocmulgee River swamp at Barrow's Bluff, COFFEE County, May 14, 1904; and probably elsewhere in similar situations.

Fl. March. Distribution in Georgia not well worked out, but it is known to grow also in the Palæozoic region, and around mayhaw ponds in the Lower Oligocene region. This tree looks much like the preceding in summer, but in winter, and still more so in early spring when the leaves are unfolding, it is very distinct.

Staten Island to central Florida, Missouri, and Texas.

CASTANEA Adans., Fam. **2**: 375. 1763.

C. pumila (L.) Mill. (no. 2), Dict. Gard. ed. 8. 1768. CHINQUAPIN.

EMANUEL: Rosemary sand-hills, June 28, 1901; MONTGOMERY: Sand-hills of Gum Swamp Creek, Sept. 10, 1903; WILCOX: Upper Seven Bluffs, May 17, 1904. Grows also in Pierce County in situations similar to that first mentioned, but it is more common farther inland, all the way to the mountains.

Widely distributed in the Eastern United States south of latitude 40°.

C. alnifolia Nutt., Gen. **2**: 217. 1818. "CHINQUAPIN."

C. nana Muhl.; Ell., Sk. **2**: 615. 1824; Kearney, Bull. Torrey Club **21**: 261–262. *pl. 206.* 1894; Small, Bull. Torrey Club **23**: 126. 1896.

C. alnifolia pubescens Nutt., Sylva **1**: 19. *pl. 6.* 1842.

Dry and intermediate pine-barrens. APPLING, COFFEE (*2202*), IRWIN, BERRIEN. Fl. May. Common in the flat country toward the coast, but not known farther inland.

South Carolina to northern Florida, in the lower half of the coastal plain. Also reported from Arkansas and Louisiana (*Sargent*).

BETULACEÆ.

ALNUS Gaert., Fr. & Sem. **2**: 54. *pl. 90.* 1791. ALDER.

A. rugosa (DuRoi) Koch, Dendrol. **2**: 635. 1872.

In branch-, creek-, and river-swamps; not common. SCREVEN, BULLOCH, TATTNALL, MONTGOMERY, DODGE, TELFAIR, COFFEE, WILCOX. Flowers in January, being probably our earliest spring flower. More common farther inland, especially in Middle Georgia.

Nearly throughout the Eastern United States.

BETULA L., Sp. Pl. 982. 1753. BIRCH.

B. nigra L., l. c.

Banks of creeks and rivers. SCREVEN, TATTNALL, TELFAIR, THOMAS (*1938*). Extends down the Ogeechee, Canoochee, and Altamaha Rivers to within about 20 miles of the coast. More common farther inland, particularly in Middle Georgia, and reaching its largest dimensions probably in Northwest Georgia.

Widely distributed in the Eastern United States outside of New England.

OSTRYA Scop., Fl. Carn. 414. 1760.

O. Virginiana (Mill.) Willd., Sp., Pl. **4**:469. 1805.

BULLOCH: Rich woods along Ogeechee River near Echo; DODGE: Hammock of Gum Swamp Creek east of Eastman; BERRIEN: Rich woods near Little River, southwest of Tifton. Rare coastward, but more common farther inland.

Widely distributed in the Eastern United States and adjacent Canada.

CARPINUS L., Sp. Pl. 998. 1753.

C. Caroliniana Walt., Fl. Car. 236. 1788. IRONWOOD.

MONTGOMERY: Oconee River swamp near Mount Vernon, TELFAIR: Ocmulgee River swamp near Lumber City; DOOLY: Lime-sink between Wenona and the Rock House. More common farther inland.

Has about the same range as the preceding.

SALICACEÆ.

SALIX L., Sp. Pl. 1015. 1753. WILLOW.

S. nigra Marsh., Arb. Am. 139. 1785.

Banks of rivers, often with *Betula nigra*, usually overhanging the water; not abundant. TATTNALL, (see Plate IX, Fig. 1.) MONTGOMERY, TELFAIR, COFFEE, THOMAS. Also in a few wet places away from rivers (TATTNALL, TELFAIR, and BERRIEN) probably introduced in some way since the country was settled up. Fl. spring. Widely distributed over the state but most common in the older parts.

Throughout the United States, or nearly so.

MYRICACEÆ.

MYRICA L., Sp. Pl. 1024. 1753.

M. Carolinensis Mill., Gard. Dict. ed. 8. 1768. (BAYBERRY.)
(Included in *M. cerifera* by nearly all 19th century authors.)
Sand-hill bogs, non-alluvial swamps, moist pine-barrens, etc. BULLOCH, EMANUEL (*982*), MONTGOMERY, COFFEE, IRWIN, DOOLY, COLQUITT. Fl. spring. Pretty well scattered over South Georgia.
Nova Scotia to Lake Erie in the glaciated region, south to northern Florida and eastern Louisiana in the coastal plain. (See Rhodora **7**:74. 1905.)
Leaf-anatomy described by Kearney, Contr. U. S. Nat. Herb. **5**:294. 1900.

M. cerifera L., l. c. MYRTLE.
BULLOCH: Rich woods along Ogeechee River near Echo (opposite Rocky Ford), March 31 and April 4, 1904. BERRIEN: Low rich woods west and southwest of Tifton, Sept. 29 and 30, 1902 (see pp. 110, 111). Fl. March. Quite abundant near the coast, and scattered pretty well over South Georgia, reaching its best development probably in the Cretaceous region. This species seems almost always to indicate the absence of the Lafayette formation.
Maryland to South Florida, Arkansas, and Texas, in the coastal plain.
Leaf-anatomy briefly described by Kearney, Contr. U. S. Nat. Herb. **5**:294. 1900.

M. pumila [Mx.] Small, Bull. Torrey Club **23**:126. 1896.
Usually in dry or intermediate pine-barrens. SCREVEN, EMANUEL (*992*), TATTNALL, MONTGOMERY, TELFAIR, APPLING, COFFEE, COLQUITT. Common in the flat country toward the coast, and extending inland to Sumter, Lee, and Early Counties in the Lower Oligocene region.
North Carolina to Florida and Mississippi, in the pine-barrens. Also in upper Alabama (*Mohr*).

JUGLANDACEÆ.

HICORIA Raf., Med. Rep. II. 5:352. 1808. "HICKORY."

H. aquatica (Mx. f.) Britton, Bull. Torrey Club **15**:284. 1888.

Swamps of muddy rivers. Oconee River near Mount Vernon and Ocmulgee River near Lumber City. Also in a few localities coastward, but more frequent in the upper third of the coastal plain.

Southeastern Virginia to central Florida, Illinois, and Texas, in the coastal plain.

H. sp. Another species (perhaps more than one), grows in hammocks in COFFEE, WILCOX, and doubtless other counties, but I have never identified it. It is probably identical with some species growing farther inland, very likely *H. alba* or *H. glabra*.

SAURURACEÆ.

SAURURUS L., Sp. Pl. 341. 1753.

S. cernuus L., l. c.

River-swamps, cypress ponds, etc.; not common. SCREVEN, MONTGOMERY, TELFAIR, COFFEE, BERRIEN. Fl. May. Scattered over the state from northwest to southeast, but apparently absent in most of the counties.

Widely but erratically distributed over the Eastern United States outside of New England. Its general as well as its local distribution is difficult to explain.

ORCHIDACEÆ.

EPIDENDRUM L., Sp. Pl. 952. 1753.

LARNANDRA Raf., Neogen. 4. 1825. (Based on the following species.)

E. conopseum R. Br. in Ait. f. Hort. Kew. ed. 2, **5**: 219. 1813. Figured in Curt. Bot. Mag. **62**: *pl. 3457.* 1835.

Usually on *Magnolia grandiflora* in hammocks. MONTGOMERY (*1870*), DODGE, COFFEE. Also in the latter county on *M. glauca* in a non-alluvial swamp near by. Fl. June–July. Extends inland to Dooly and Early Counties in the Lower Oligocene region and coastward to Brooks, Thomas, and Decatur. (See Bull. Torrey Club **32**: 159. 1905.)

South Carolina to Florida and Mississippi, in the pine-barren region and coastward.

TIPULARIA Nutt., Gen. 2: 195. 1818.

PLECTRURUS Raf., Neogen. 4. 1825.

T. discolor (Pursh) Nutt., l. c.

(?) *Limodorum unifolium* Muhl., Cat. 81. 1813. (*nomen nudum.*)

EMANUEL: Hammock of Little Ohoopee River, April 5, 1904. More common in the upper parts of the coastal plain, and northward. Also in Thomas County, a little south of our limits. Fl. August.

Vermont to Michigan, Middle Florida, and Louisiana.

For notes on the mycorhiza of this species see Clifford, Bull. Torrey Club 26: 635–638. *pl. 372.* 1899.

POGONIA Juss., Gen. Pl. 65. 1789.

P. divaricata (L.). R. Br. in Ait. f. Hort. Kew. ed. 2, 5: 203. 1813.

Moist pine-barrens, especially near branch-swamps; not common. BULLOCH (*883*), EMANUEL (*812*, *816*), COFFEE, WILCOX, IRWIN, BERRIEN. Rarely as many as a dozen specimens can be seen at one time. Fl. May–June.

New Jersey to northern Florida and Alabama, mostly in the pine-barrens. Also in the mountains of East Tennessee (*Gattinger*).

P. ophioglossoides (L.) Ker., Bot. Reg. 2: *pl. 148.* 1816.

In similar situations to the preceding, but commoner. BULLOCH (*2162*), TATTNALL, COFFEE, WILCOX, IRWIN, BERRIEN, COLQUITT. Fl. April–May.

Widely distributed in the coastal plain and glaciated region of temperate Eastern North America, but rare in the mountains and Piedmont region. Also reported from Japan.

LIMODORUM L., Sp. Pl. 950. 1753.

L. tuberosum L., l. c.

Moist pine-barrens. BULLOCH (*877*), COFFEE, WILCOX, IRWIN, BERRIEN. Fl. May–July. Inland to the vicinity of Americus and coastward to Charlton County.

General distribution in North America similar to that of the preceding. Also reported from the Bahamas (*Northrop*).

L. graminifolium (Ell.) Small, Fl. 322, 1329. 1903.

In similar situations to the preceding, of which it is perhaps

only a reduced form. BULLOCH (*851*), COFFEE, BERRIEN. Fl. May–July. Also in Bryan County.

North Carolina to central Florida and Louisiana, in the pine-barrens.

HABENARIA Willd., Sp. Pl. **4** : 44. 1805.

H. blephariglottis (Willd.) Torr., Comp. 317. 1826.

Intermediate and moist pine-barrens and sand-hill bogs; not common. MONTGOMERY, APPLING, COLQUITT (*1944*), DECATUR. Fl. Aug.–Sept. Inland to the vicinity of Americus, but probably more abundant in the flat pine-barrens toward the coast.

Widely distributed in the glaciated region and coastal plain (see Rhodora **7** : 73, 74. 1905). Also in Middle Tennessee (*Gattinger*).

H. ciliaris (L.) R. Br. in Ait. f. Hort. Kew. ed. 2, **5** : 194. 1813.

Often with the preceding, and commoner. COFFEE, IRWIN, WORTH, COLQUITT (*1943*), MITCHELL, THOMAS, DECATUR. Fl July–Aug. Inland to Americus (and rarely in Northwest Georgia), and coastward to Glynn and Camden Counties.

Range similar to that of the preceding, but extending farther inland in the South and not quite so far west in the North (see Rhodora **7** : 73. 1905).

Plants intermediate in appearance between this and the preceding, and probably hybrids, have been seen growing with them in COLQUITT and Lowndes Counties. The same phenomenon has been noted elsewhere by Dr. Morong (Bull. Torrey Club **20** : 469. 1893).

H. cristata (Mx.) R. Br., l. c.

Moist pine-barrens and swamps; not common. COFFEE, COLQUITT, THOMAS, DECATUR. Fl. July–Aug. Also inland to Sumter County, but I do not know how far coastward, for I have probably sometimes confused it with the next.

New Jersey to Florida, Missouri, and Louisiana, mostly in the coastal plain.

H. integra (Nutt.) Spreng., Syst. **3** : 689. 1826.

Moist pine-barrens. DOOLY, COLQUITT (*1948*), DECATUR. Fl.

August. Not easily distinguishable from the preceding a short distance away, and certainly more closely related to it than to the following species. Occurs also in the flat country.

New Jersey to Florida (?) and Louisiana, in the coastal plain. Also in Middle Tennessee (*Gattinger*).

H. nivea (Nutt.) Spreng., l. c. (Plate XXV, Fig. 1.)

Intermediate and moist pine-barrens; not abundant. BULLOCH (*852, 954*), EMANUEL, TATTNALL, MONTGOMERY, DODGE, TELFAIR. Fl. June–July. Also in the Lower Oligocene region in Sumter and Lee Counties, and coastward to Bryan County.

Delaware and South Carolina to Florida, Arkansas, and Louisiana, nearly confined to the pine-barrens.

BURMANNIACEÆ.

BURMANNIA L., Sp. Pl. 287. 1753.

B. capitata (Walt.) Mart., Nov. Gen. & Sp. Pl. Bras. **1**:12. 1824. (See Torreya **1**:34. 1901; Bull. Torrey Club **28**:470. 1901.)

Moist pine-barrens; not rare but very inconspicuous. DODGE, COFFEE, IRWIN, BERRIEN (*669*), DOOLY, WORTH, COLQUITT, DECATUR. Fl. Aug.–Oct. Seems to reach its inland limit near Cordele, at the extreme edge of our territory.

North Carolina to central Florida and Louisiana, in the pine-barrens. Also in the West Indies and South America (if the tropical plant is correctly identified).

B. biflora L. ought to grow in our territory, but I have never seen it there. *Apteria*, the related genus, is known at several points in the Upper Oligocene region, just south of our limits.

IRIDACEÆ.

IRIS L., Sp. Pl. 38. 1753.

I. versicolor L., Sp. Pl. 39. 1753.

Mostly in and near branch-swamps, more rarely around permanent ponds or in low woods. BULLOCH, TATTNALL, MONTGOMERY, DODGE, TELFAIR, COFFEE, WILCOX, BERRIEN, COLQUITT. Fl. April–May. Pretty widely distributed in the pine-barrens of Georgia, but not seen in other parts of the state.

Nearly throughout the glaciated region and coastal plain of temperate Eastern North America. Also said to occur throughout Tennessee (*Gattinger*) and Alabama (*Mohr*).

SISYRINCHIUM L., Sp. Pl. 954. 1753.

S. Atlanticum Bicknell, Bull. Torrey Club **23**: 134. *pl. 264*. 1896.

Moist pine-barrens. TATTNALL (*2149*), BERRIEN (*2197*), and doubtless other counties. Fl. April.

Said to range from Maine to Florida. My material could be referred with equal certainty to *S. Floridanum* or *S. fuscatum*, two species described by Mr. Bicknell in 1899 from the pine-barrens of the Gulf states.

DIOSCOREACEÆ.

DIOSCOREA L., Sp. Pl. 1032. 1753.

D. villosa L., Sp. Pl. 1033. 1753.

In shaded situations, only in those exceptional places already mentioned where the Lafayette and perhaps the Altamaha Grit too is wanting. BULLOCH: Wooded bluff near Echo; WILCOX: Upper Seven Bluffs; BERRIEN: Low woods west of Tifton; DOOLY: Lime-sink near the Rock House. Fl. April–July. Commoner farther inland, all the way to the mountains. Its local and general distribution is very similar to that of *Cercis Canadensis* (which see), which accompanies it at each of the above-mentioned stations.

Widely distributed in the Eastern United States north of latitude 30°.

AMARYLLIDACEÆ.

HYMENOCALLIS Sal. Trans. Hort. Soc. **1**: 338. 1812. SPIDER LILY.

H. sp. (See Bull. Torrey Club **32**: 463–465. *f. 5*. 1905.)

A species with only two flowers, more rarely one, on a scape, and narrow leaves, grows in creek-swamps in COFFEE and COLQUITT, flowering in April and May. (See Plate XXIV, Fig. 2). Although its characters are not at all obscure, and good specimens have been collected (outside of our territory), it cannot be determined in the present rather confused state of the literature relating to this genus. It was

evidently known to LeConte, but does not seem to have been given a tenable name in his writings.

H. sp.

What is probably a totally different species, identical with one which is frequent in the Lower Oligocene region, was observed in the Ocmulgee River swamp near Barrow's Bluff, COFFEE County, May 14, 1904, but not in flower.

MANFREDA Sal., Gen. Pl. Fragm. 78. 1866.

M. Virginica (L.) Jackson, Ind. Kew. 2:161. 1894; Rose, Contr. U. S. Nat. Herb. 5:155. 1899.

Agave Virginica L., Sp. Pl. 323. 1753.

Rock outcrops in TATTNALL and DODGE, and dry pine-barrens in COLQUITT. Fl. June–July. More common farther inland, all the way to the mountains, but nowhere abundant.

Widely distributed in the Southeastern United States.

HYPOXIS L., Syst. ed. 10, 2:986. 1759.

H. juncea J. E. Smith, Spicil. 15. *pl. 16.* 1792.

H. filifolia Ell., Sk. 1:397. 1817.

MONTGOMERY: Outer base of sand-hills of Gum Swamp Creek west of Erick, Sept. 10, 1903; COFFEE: Intermediate pine-barrens near Bushnell Junction, May 10, 1904. Fl. May–Sept. Accompanied at the first locality by *Sporobolus Curtissii*, which frequently grows with it in the flat country toward the coast.

South Carolina to Florida and Mississippi, in the pine-barrens. Also in the Bahamas (*Northrop*).

HÆMODORACEÆ.

GYROTHECA Sal., Trans. Hort. Soc. 1:327. 1812.

G. tinctoria (Walt.) Sal., l. c. (See Torreya 1:33–34. 1901.)

Branch-swamps, etc.; not common. COFFEE, WILCOX, IRWIN. Fl. June–July. More characteristic of other parts of the pine-barrens, ranging inland to Sumter County and coastward to Camden.

Massachusetts to South Florida and Mississippi, in the coastal plain. Also in the West Indies (?).

LOPHIOLA Ker, Curt. Bot. Mag. **40**: *pl. 1596.* 1813.

(The affinity of this genus with the preceding is too obvious to allow them to be placed in different families merely on account of a difference in the number of stamens, as has been done by Engler & Prantl and subsequent authors.)

L. aurea Ker, l. c. (See Barnhart, Torreya **4**: 132, 135. 1905.)

Moist pine-barrens. MONTGOMERY (seen from train near Erick, July 4, 1901, July 3, 1903), COFFEE (*1432*), WILCOX (common in southeastern corner), IRWIN (*1417*). Fl. June–July. Also in Ware County, a little southeast of our limits.

New Jersey to West Florida and Mississippi, in the pine-barrens.

ALETRIS L., Sp. Pl. 319. 1753.

A. obovata Nash; Small, Fl. 286. 1903; Torreya **4**: 102. 1903.

Intermediate pine-barrens; not rare. WARE (probably extra-limital), COFFEE (*2201*), WILCOX, IRWIN, BERRIEN. Fl. May.

Known otherwise only from the type-locality in northeastern Florida. (See Bull. Torrey Club **32**: 463. 1905.)

Before this species was described I noted what I took to be *A. farinosa* in many similar places in the region, but it was probably all *A. obovata.* What seems to be genuine *A. farinosa* grows in the Lower Oligocene region and farther inland, however.

A. lutea Small, Bull. N. Y. Bot. Gard. **1**: 278. 1899.

Intermediate or slightly moist pine-barrens. Quite common in COFFEE and BERRIEN (*2193*), and in some of the counties nearer the coast. (See Bull. Torrey Club **32**: 154. 1905.) Fl. May.

South to Florida and west to Louisiana(?), in the pine-barrens.

What is doubtless a hybrid between this and the preceding was seen growing with them in COFFEE County, May 11, 1904.

A. aurea Walt., Fl. Car. 121, 1788.

Moist pine-barrens. TATTNALL, MONTGOMERY, DODGE, TELFAIR, COFFEE, WILCOX, IRWIN, DOOLY, COLQUITT, THOMAS. Fl. June–July. Inland to the southeastern part of Sumter County, and coastward to the vicinity of Waycross.

Virginia to Florida and Texas, in the pine-barrens.

SMILACACEÆ.

SMILAX L., Sp. Pl. 1028. 1753.

S. pumila Walt., Fl. Car. 244. 1788.

Very elastic in habitat, growing in dry pine-barrens, sand-hills, hammocks, bluffs, etc. BULLOCH, EMANUEL, TATTNALL, MONTGOMERY, DODGE, COFFEE, WILCOX, IRWIN, BERRIEN (*1688*), COLQUITT. Flowers in September, and probably at other times. Pretty widely distributed in South Georgia, but never seen more than a mile or two above the fall-line

South Carolina to central Florida and Texas, very nearly confined to the coastal plain.

S. auriculata Walt., Fl. Car. 245. 1788; Chapm., Fl. 476. 1860.

S. Beyrichii Kunth, Enum. **5**: 207. 1850; Morong, Bull. Torrey Club **21**: 430. 1894.

MONTGOMERY: Sand-hills of Little Ocmulgee River opposite Lumber City, Sept. 10, 1903. Also in the hammock of the Altamaha River in McIntosh County, and on St. Simon's Island, Glynn County.

North Carolina to Florida and Mississippi, mostly near the coast. Also in the Bahamas (*Northrop*). See Nash, Bull. Torrey Club **22**: 144. 1895; Mohr, Contr. U. S. Nat. Herb. **6**: 445. 1901.

S. laurifolia L., Sp. Pl. 1030. 1753. BAMBOO VINE.

In swamps, especially non-alluvial creek-swamps. SCREVEN, BULLOCH, (*955*) TATTNALL, MONTGOMERY, DODGE, APPLING, COFFEE, WILCOX, IRWIN, COLQUITT, DECATUR. Pretty common throughout South Georgia, except perhaps in the lime-sink region and near the coast.

New Jersey to South Florida, Arkansas, and Louisiana, in the coastal plain. Also in East Tennessee (*Gattinger*).

Leaf-anatomy described by Kearney, Contr. U. S. Nat. Herb **5**: 486. *f. 86*. 1901.

S. Walteri Pursh, Fl. 249. 1814. SARSAPARILLA.

In Gum Swamp Creek near McRae, July 3, 1903. More common in the upper third of the coastal plain.

New Jersey to northern Florida, Tennessee (?), and Louisiana, in the coastal plain.

Leaf-anatomy studied by Kearney, Contr. U. S. Nat. Herb. **5**:487. 1901.

LILIACEÆ.

NOLINA Mx., Fl. 1:207. 1803.

N. Georgiana Mx., l. c. 208.

BULLOCH: Sand-hills of Big Lott's Creek, June 27, 1902 (*965*); DODGE: Rock outcrop near Eastman, Sept. 8, 1903. Fl. spring. Common on the fall-line sand-hills in Richmond, Columbia, Jones, and Bibb Counties, and known from Washington, Johnson, and Laurens Counties in the upper third of the coastal plain.

Said to occur in corresponding parts of South Carolina, and in Florida.

YUCCA L., Sp. Pl. 319. 1753.

Y. filamentosa L., l. c. "BEAR GRASS."

Dry pine-barrens, sand-hills, etc.; not common. BULLOCH, EMANUEL, COFFEE, IRWIN, BERRIEN, DOOLY. Fl. May–June Common in the upper third of the coastal plain, and in Middle Georgia, but there apparently only as a weed in old fields.

Widely distributed in the Southeastern United States, but natural range and habitat not well understood.

OXYTRIA Raf., Fl. Tell. 2:26. 1836; Pollard, Bull. Torrey Club 24:405. 1897.

O. crocea (Mx.) Raf., l. c.

BERRIEN: In and near small open branch-swamps, near Nashville (*2194*) and Tifton, May, 1904, in flower. Rare. (Collected by *Curtiss* near Allapaha, in the same county).

Total range not well worked out.

LILIUM L., Sp. Pl. 303. 1753.

L. Catesbæi Walt, Fl. Car. 123. 1788.

L. spectabile Sal., Ic. Pl. Rar. 9. *pl. 5*. 1791.

Moist pine-barrens, rather rare. COFFEE, DOOLY, WORTH, COLQUITT. Fl. Aug.–Sept. Pretty widely distributed through the pine-barrens of Georgia, but rarely as many as a dozen specimens visible at once.

North Carolina to central Florida and Mississippi, in the pine-barrens.

NOTHOSCORDUM Kunth, Enum. 4 : 457. 1853.

N. bivalve (L.) Britton, Ill. Fl. 1 : 415. *f. 1001.* 1896.

Allium striatum Jacq., Coll. Suppl. 51. 1796.

BERRIEN: Shallow exsiccated pond near Tifton, Oct. 2, 1902, in flower (*1706*). Also occurs as a weed in some other places a few miles away, but possibly not indigenous in our territory at all. I have seen it oftener on flat granite outcrops in Middle Georgia.

Said to range from Virginia to Chile, but natural range and habitat not well understood.

ALLIUM L., Sp. Pl. 294. 1753.

A. Cuthbertii Small, Fl. 264. 1903.

WILCOX: Rock outcrops near the center of the county, May 18, 1904, in flower (*2212*). Also occurs on and near the fall-line sand-hills in Richmond County (type-locality).

Distribution and habitat not well worked out.

MELANTHACEÆ.

MELANTHIUM L., Sp. Pl. 339. 1753.

M. Virginicum L., l. c.

Moist pine-barrens; not common. TELFAIR, WILCOX, IRWIN. Fl. June–July. Also in Sumter County near Americus.

Widely distributed in the Eastern United States north of latitude 30°.

ZYGADENUS Mx., Fl. 1 : 213. 1803.

Z. glaberrimus Mx., Fl. 1 : 214. *pl. 22.* 1803.

Sandy bogs, etc.; rare. MONTGOMERY (*1984*), THOMAS. Fl. July–Aug. Seen once near Americus.

Virginia (?) to West Florida and Louisiana in the coastal plain, very nearly confined to the pine-barrens.

OCEANOROS Small, Fl. 252. 1903.

O. leimanthoides (Gray) Small, l. c.

Amianthium leimanthoides Gray, Ann. Lyc. N. Y. 4 : 125. 1837.

Zygadenus leimanthoides Wats., Proc. Am. Acad. 14 : 280. 1879.
Sand-hill bogs, rare. EMANUEL (*989*), MONTGOMERY. Fl. June. Not seen elsewhere in the state.
New Jersey to Alabama, in the coastal plain and mountains.

TRACYANTHUS Small, Fl. 250. 1903.

T. angustifolius (Mx.) Small, l. c. 251.
Amianthium angustifolium Gray, Ann. Lyc. N. Y. 4: 124. 1837.
Zygadenus angustifolius Wats., Proc. Am. Acad. 14: 280. 1879.
Moist pine-barrens, borders of branch-swamps, and sand-hill bogs. BULLOCH, TATTNALL (*2150*), MONTGOMERY, COFFEE, WILCOX, BERRIEN, and probably in other counties, but easily overlooked when not in flower. Blooms from about the middle of April to the middle of May. Not seen farther inland, but extends coastward to Glynn County.
North Carolina to central Florida and Mississippi, in the pine-barrens. Also in western North Carolina (*Small & Heller*).

CHROSPERMA Raf., Neogen. 3. 1825.

C. muscætoxicum (Walt.) Kuntze, Rev. 2 : 708. 1891.
Dry pine-barrens, etc.; rare. BULLOCH, EMANUEL (*815*), MONTGOMERY. Fl. May–June. Extends inland to Middle Georgia, where it grows usually in rich woods.
New Jersey to Arkansas, West Florida, and Louisiana.

CHAMÆLIRIUM Willd., Mag. Nat. Fr. Berl. 2 : 18. 1808.

C. luteum (L.) Gray, Man. 503. 1848.
Dry or rather dry pine-barrens; not common. WARE (perhaps extralimital), COFFEE, BERRIEN, May 5, 1904, in flower. Grows also in rich woods in Middle Georgia, like the preceding.
Widely distributed in the Eastern United States.

TOFIELDIA Huds., Fl. Angl. 2 : 157. 1778.

T. racemosa (Walt.) B. S. P., Prel. Cat. N. Y. 55. 1888; Morong, Mem. Torrey Club 5 : 109. 1894. (See Plate XXIV, Fig. 1).
Moist pine-barrens. Common from MONTGOMERY County

southwestward, and probably northeastward also. Fl. June–Aug. Inland to Sumter and Randolph Counties and coastward to Charleston.

New Jersey to northern Florida and Louisiana, in the coastal plain.

JUNCACEÆ.

JUNCUS L., Sp. Pl. 325. 1753.

J. Elliottii Chapm., Fl. 494. 1860.

"*J. acuminatus* (?) Mx." Ell., Sk. 1:409. 1817.

(?) *J. Pondii* Wood, Class-Book, 724. 1861.

Branch-swamps, etc., sometimes ruderal; rather rare. BULLOCH (*841*, *864*, *869*), EMANUEL. Possibly not indigenous.

North Carolina to central Florida and Texas, in the coastal plain.

J. diffusissimus Buckl., Proc. Acad. Phila. **1862**: 9. 1862.

EMANUEL: Marshy place near Stillmore, July 3, 1901 (*995*). (See Bull. Torrey Club **30**: 327. 1903.) As I have not met with it since, its indigeneity may be doubted.

Ranges mostly westward.

J. trigonocarpus Steud., Syn. Pl. Cyp. 308. 1855.

Moist pine-barrens, etc.; common. EMANUEL, DODGE, COFFEE (*717*), IRWIN, BERRIEN (*667*), DOOLY, WORTH, COLQUITT, DECATUR. Fl. Aug.–Sept. Inland to Americus and Meriwether County (see Bull. Torrey Club **30**: 294. 1903) and coastward to Charlton County.

South Carolina to Middle Florida and Mississippi, mostly in the pine-barrens.

J. polycephalus Mx., Fl. 1: 292. 1803.

Typically in rather open branch-swamps, more rarely in other related habitats. BULLOCH, EMANUEL, TATTNALL, MONTGOMERY, TELFAIR, COFFEE, WILCOX, IRWIN, COLQUITT. Pretty widely distributed in the pine-barrens of Georgia.

North Carolina to northern Florida and Texas, in the pine-barrens.

J. scirpoides compositus Harper, Bull. Torrey Club **33**: 233. 1906.

Margins of sand-hill ponds and bogs. DODGE, COFFEE (*1445*),

BERRIEN. Fl. July. Also in several counties nearer the coast, but not seen farther inland.

South Carolina to Florida, in the coastal plain.

J. **biflorus** Ell.; Sk. 1 : 407. 1817.

J. marginatus biflorus Chapm., Fl. 495. 1860.

J. aristulatus pinetorum Coville; Small, Fl. 259. 1803.

Typically in moist pine-barrens, more rarely on sand-hills or around the bogs at their bases. BULLOCH (*868*), EMANUEL, TATTNALL, MONTGOMERY, DODGE, TELFAIR, COFFEE, IRWIN, BERRIEN, DOOLY, COLQUITT. Fl. May–June. Pretty widely distributed in the pine-barrens of Georgia (see Bull. Torrey Club **33**: 232. 1906.)

North Carolina to Florida, in the pine-barrens.

J. **repens** Mx., Fl. 1 : 191. 1803.

Cephaloxys flabellata Desv., Jour. Bot. 1: 324 *pl. 2*. 1808.

Branch-swamps and shallow ponds, or more commonly a weed in ditches. EMANUEL, COFFEE, IRWIN. Pretty well distributed over the pine-barrens of Georgia.

North Carolina to Florida, Arkansas, and Texas, in the coastal plain. Also in Cuba.

Anatomy discussed by Holm, Bull. Torrey Club **26**: 359–364. *pl. 363*. 1899.

J. **dichotomus** Ell., Sk. 1: 406. 1817; Wiegand, Bull. Torrey Club **27**: 525–527. 1900.

SCREVEN and BULLOCH, in various habitats, but not well understood and perhaps not indigenous. Quite common along the Central R.R. from Millen to Savannah.

This has been more or less confused with other species, and its distribution has not been satisfactorily worked out.

J. BUFONIUS L., Sp. Pl. 328. 1753.

BULLOCH: A weed on damp roadsides near Bloys (*862*).

Cosmopolitan, but natural range and habitat unknown.

BROMELIACEÆ.

DENDROPOGON Raf., Neogen. 3. 1825.

D. **usneoides** (L.) Jackson, Ind. Kew. 1: 733. 1893. "Moss." HANGING MOSS.

Tillandsia usneoides L., Sp. Pl. ed. 2. 411. 1762.

On various trees, mostly in hammocks and river-swamps. It seems to have a decided preference for trees growing in calcareous soil, and is therefore not as common in our territory as in the lime-sink region and along the coast. Ranges throughout South Georgia, but I have never seen it in Middle Georgia except once near the Chattahoochee River a mile or two above the fall-line in Muscogee County. Its range is similarly restricted in Alabama, according to Mohr and Earle, but just why this should be the case is a mystery.

Virginia to South Florida and Texas, in the coastal plain. Also in tropical America.

For an anatomical study see F. H. Billings, Bot. Gaz. **38**: 99–120. *f. 1. pl. 8–11.* 1904.

PONTEDERIACEÆ.

PONTEDERIA L., Sp. Pl. 288. 1753.

P. cordata L., l. c.

A typical inhabitant of cypress ponds, more rarely in other ponds, and in streams. Quite common throughout the pine-barrens of Georgia and in brackish marshes along the coast. Not seen farther inland than the outlying area of pine-barrens near Omaha (see Bull. Torrey Club **32**: 457. *f. 3.* 1905.)

In our territory it nearly always has narrow leaf-blades, quite different from the robust broad-leaved forms in the brackish marshes, but all gradations between them can be found. Fl. April–Aug.

Nearly throughout the glaciated region and coastal plain of temperate Eastern North America (see Rhodora **7**: 73. 1905). Also reported from Central and South America, which deserves closer investigation.

COMMELINACEÆ.

TRADESCANTIA L., Sp. Pl. 288. 1753.

T. reflexa Raf., New Fl. N. A. **2** :87. 1836; Small, Bull. Torrey Club **24** : 232. 1897.

Sand-hills; rare. BULLOCH, COFFEE. Fl. June.

Range not fully worked out.

CUTHBERTIA Small, Fl. 237. 1903.

C. graminea Small, l. c.

Tradescentia rosea Vent., in part.

Sand-hills. BULLOCH (*913*), EMANUEL (*817*), TATTNALL, MONTGOMERY, TELFAIR, COFFEE, WILCOX. Fl. May–July. Also on the fall-line sand-hills in Richmond County, where it was discovered.

Maryland (?) to Florida, Missouri (?), and Texas (?), in the coastal plain.

ERIOCAULACEÆ.

ERIOCAULON L., Sp. Pl. 87. 1753.

E. decangulare L., l. c. BUTTONS. "WHITE-HEADS." (See Plate XXIV, Fig. 1).

One of the most abundant and characteristic plants of moist pine-barrens; more rarely in swamps. Common throughout the pine-barrens of Georgia, and a little farther inland almost to Sandersville and Americus. Fl. June–Sept.

New Jersey to central Florida and Texas in the coastal plain, and locally inland in the mountains of North Carolina, Tennessee, and Alabama.

Anatomy discussed by Holm, Bot. Gaz. **31**: 17–37. *f. 1–5.* Jan. 1901.

E. lineare Small, Fl. 236. 1903. (See Plate XXIII, and XXV, Fig. 2).

With the preceding in our territory, and equally abundant wherever it grows, but as it is almost invisible except in spring, I have not noted it so often. (See Bull. Torrey Club **32**: 461–463. *f. 4.* 1905). BULLOCH (*830*, type, collected in a branch-swamp, an exceptional habitat), TATTNALL, MONTGOMERY (*2146*), COFFEE, WILCOX, IRWIN, BERRIEN. Fl. April–May. Inland to Sumter County.

Not yet known outside of Georgia. (see Torreya **5**: 114. 1905).

E. compressum Lam., Encyc. **3**: 276. 1789.

Cypress and other ponds; not rare. SCREVEN, TATTNALL, COFFEE, WILCOX, IRWIN, BERRIEN, and doubtless elsewhere. Flowers in March and April, and easily overlooked later in the season.

New Jersey to central Florida and Texas, in the coastal plain.

SYNGONANTHUS Ruhl. in Urban, Symb. Ant. 1 : 487. 1900.

S. flavidulus (Mx.) Ruhl. in Engler's Pflanzenreich 4^{30} : 256. 1903.

Eriocaulon flavidulum Mx., Fl. 2 : 166. 1803. (Not *E. flavidulum* Ruhl., Pflanzenreich 4^{30}: 33. 1903.)

Dupatya flavidula Kuntze, Rev. 2 : 745. 1891.

Moist pine-barrens and margins of sand-hill ponds and bogs, always on the Columbia sand; common. EMANUEL (*803*), TATTNALL, MONTGOMERY, DODGE, TELFAIR, APPLING, COFFEE, WILCOX, IRWIN, BERRIEN, DOOLY, COLQUITT, DECATUR. Fl. May–Sept. Seen only once farther inland (near Coney, Dooly Co.), but common in the flat country toward the coast.

Virginia (?) to central Florida and Alabama, in the pine-barrens.

LACHNOCAULON Kunth, Enum. 3 : 497. 1841.

L. anceps (Walt.) Morong, Bull. Torrey Club 18 : 360. 1891.

With the preceding or often in slightly drier places; less common. EMANUEL (*804*), TATTNALL, MONTGOMERY, COFFEE, IRWIN, BERRIEN, COLQUITT, DECATUR. Fl. April–Aug. Pretty widely distributed in South Georgia, mostly in the pine-barrens.

North Carolina to central Florida and Mississippi, in the coastal plain. Also on Lookout Mountain, Alabama (*A. Ruth*).

XYRIDACEÆ.

XYRIS L., Sp. Pl. 42. 1753.

X. Baldwiniana Schult., Mant. 1 : 351. 1822.

Moist pine-barrens and margins of sand-hill ponds. BULLOCH (*848*), TATTNALL, MONTGOMERY, COFFEE, IRWIN, COLQUITT. Fl. all summer. Inland to the pine-barrens of Laurens and Sumter Counties. Originally discovered in Camden County, in the southeastern corner of the state, but probably not seen there lately.

North (?) Carolina to central Florida and Texas, in the pine-barrens.

X. flexuosa Muhl.; Ell. Sk. 1 : 51. 1816.

X. torta of many authors (see Torreya **5** : 129. 1905).

Intermediate pine-barrens; not abundant. TELFAIR, COFFEE, IRWIN, BERRIEN, COLQUITT, THOMAS, DECATUR. Fl. July–Aug. General distribution in Georgia about like that of the preceding.

New Jersey to Florida, Arkansas, and Texas, mostly in the pine-barrens.

X. fimbriata Ell., Sk. 1 : 52. 1816.

Sand-hill ponds and related habitats. APPLING, COFFEE, IRWIN, BERRIEN, DOOLY, COLQUITT. Fl. July–Sept. Extends inland to Sumter County and coastward to Camden, but I have not yet observed it north of the Altamaha River and its tributaries, perhaps because I have not been in that part of the state much when it was in flower.

New Jersey (?) to central Florida and Louisiana, in the pine-barrens.

X. Smalliana Nash, Bull. Torrey Club **22** : 159. 1895.

COFFEE: Cypress pond at outer edge of sand-hills of Seventeen Mile Creek near Chatterton, July 29, 1902, in flower (*1453*). Also noted in Stewart (see Bull. Torrey Club **30** : 325. 1903; **32** : 457. 1905) and Pulaski Counties, and in Okefinokee Swamp.

Discovered in central peninsular Florida.

X. Elliottii Chapm., Fl. 500. 1860.

"*X. brevifolia* Mx.," Ell., Sk. 1 : 52. 1816.

COFFEE: Margins of sand-hill ponds, etc.; three or four stations within seven miles of Douglas, July, 1902 (*1448*). Fl. June–Aug. Also in several counties nearer the coast.

South Carolina to central Florida and Mississippi, in the pine-barrens.

X. sp.

COFFEE: With the two preceding, at two stations a few miles apart (*1452*). Fl. July–Aug. Scapes erect, solitary or nearly so. Flowers closing earlier in the morning than those of *X. Smalliana*.

X. platylepis Chapm., Fl. 501. 1860.

Moist pine–barrens and sand-hill bogs; rather rare. COFFEE (*1423*), COLQUITT (*1941*), THOMAS (*1174*). Fl. July–Aug. Not observed elsewhere in the state.

South Carolina to central Florida, in the pine-barrens.

X. sp.

Chiefly in creek-swamps. A shade-loving species, with acute spikes and dark bracts. COFFEE, BERRIEN (*1700*), WORTH, COLQUITT. Fl. Aug.–Sept. What seems to be the same thing extends inland to Sumter County and coastward to the vicinity of Okefinokee Swamp.

X. neglecta Small, Bull. Torrey Club **21**:300. 1894.

(?) *X. bulbosa minor* Wood, Class-Book. 728. 1861.

COFFEE: Sand-hill ponds (*1446*) and moist pine-barrens (*2013*) Fl. summer.

Known otherwise from northeastern Florida and the pine-barrens of Mississippi.

X. ambigua Beyr.; Kunth, Enum. **4**:13. 1843.

MONTGOMERY: Branch-swamp near Mount Vernon, June 29, 1903, in flower (*1863*). Discovered by Beyrich in Effingham County.

North Carolina to northern Florida and Texas, in the pine-barrens.

X. brevifolia Mx., Fl. **1**:23. 1803.

COFFEE: Rather dry pine-barrens and corresponding places in the sand-hills, three or four stations. Fl. spring. More common in the flat country toward the coast.

North Carolina to central Florida, in the pine-barrens.

MAYACACEÆ.

MAYACA Aubl., Pl. Guian. 1:42. 1775.

M. Aubleti Mx., Fl. **1**:26. 1803.

M. Michauxii Schott & Endl., Melet. **1**:24. 1832.

Moist pine-barrens and sand-hill bogs; not rare. EMANUEL, TATTNALL, MONTGOMERY, DODGE, COFFEE, WILCOX, IRWIN,

DOOLY, WORTH, COLQUITT. Fl. all summer. Inland to Americus and coastward to Folkston.

Virginia to Florida and Texas, in the coastal plain.

M. fluviatilis Aubl., l. c., *pl. 15*.

In our territory seen only in Heard's Pond, THOMAS, where it is of course not native. (See remarks under *Nympha æorbiculata*, p. 237). Possibly only a form of the preceding (see Bull. Torrey Club **30**: 234. 1903).

Commoner in Florida and the tropics.

LEMNACEÆ.

LEMNA L., Sp. Pl. 970. 1753.

L. sp.

MONTGOMERY: Floating in large sand-hill pond opposite Lumber City, Sept. 10, 1903.

ARACEÆ.

ARISÆMA Mart., Flora 14: 459. 1839.

A. triphyllum (L.) Torr., Fl. N. Y. **2**: 239. 1843. (INDIAN TURNIP).

BERRIEN: Low woods just southwest of Tifton, Sept. 29, 1902. Fl. spring. Scattered over the state, most common northward. (Seen once within 5 feet of sea-level in Liberty County.)

Nearly throughout temperate Eastern North America, but rather rare in the coastal plain.

PELTANDRA Raf., Jour. Phys. 89: 103. 1819.

P. sagittifolia (Mx.) Morong, Mem. Torrey Club **5**: 102. 1894. Figured in Meehan's Native Flowers and Ferns, **1**: 121–124. *pl. 31*. 1879.

Non-alluvial swamps; rare. COFFEE (*1449*), BERRIEN. Fl. May–July. Known otherwise in the state only from Okefinokee Swamp. Said by Elliott (Sk. **2**: 632) to have once been abundant near Savannah.

Virginia (?) to central Florida and Mississippi, in the pine-barren region.

ORONTIUM L. Sp. Pl. 324. 1753.

O. aquaticum L., l. c.

Sluggish but not muddy creeks and rivers. BULLOCH: Big

Lotts Creek, June 24, 1901, April 28, 1904 (seen from train). MONTGOMERY: Little Ocmulgee River; COFFEE: Seventeen Mile Creek (*1456*); BERRIEN and WORTH: Little River. Fl; March. Pretty widely distributed over South Georgia.

Massachusetts to Central New York, central Florida, Missouri, and Texas, mostly in the glaciated region and coastal plain. See Rhodora **1** : 184, 202; **3** : 186; **7** : 73.

PALMÆ.

SERENOA Hook. f., in B. & H., Gen. Pl. **3** : 926, 1228. 1883.

S. serrulata (Mx.) "SAW PALMETTO."

Sand-hills, dry and intermediate pine-barrens, or rarely in creek swamps. Very common in the lower counties, but rather rare or absent in the upper ones. It does not quite reach the Altamaha Grit escarpment, and I have not seen it in the counties of Screven, Emanuel, Laurens, Dodge, Dooly, Worth, Mitchell, and Decatur, in our territory. But in the last-named it is known at two or three places in the lime-sink region. It is very abundant in the flat pine-barrens toward the coast, and extends even to the dunes on the outer edges of the sea islands. Its size seems to vary approximately in inverse proportion to its distance from the coast. Flowers in June (perhaps not every year though), and fruits in September.

South Carolina to South Florida and Louisiana, in the lower half of the coastal plain.

SABAL Adans., Fam. **2** : 495. 1763.

S. glabra (Mill.) Sarg., Silva N. A. **10** : 38. 1896. PALMETTO.

S. Adansonii Guerns.; *S. minor* (Jacq.) Pers.; *S. pumila* (Walt.) Ell.; *Chamærops acaulis* Mx.

Mostly in swamps of rivers rising north of our territory SCREVEN, BULLOCH, TATTNALL, MONTGOMERY, TELFAIR, COFFEE, BERRIEN. Fl. June–July. Scattered over the coastal plain of Georgia, most common in the upper third, but stopping abruptly at the fall-line.

North Carolina to central Florida, Arkansas, and Texas, in the coastal plain.

CYPERACEÆ.

CAREX L., Sp. Pl. 972. 1753.

C. **reniformis** [Bailey] Small, Fl. 220. 1903.

Swamps of rivers rising north of our territory. TATTNALL: Ohoopee River swamp west of Reidsville (*2153*); COFFEE: Barrow's Bluff, May 14, 1904.

Known otherwise only from Mississippi and Louisiana.

C. **alata** Torr., Ann. Lyc. N. Y. **3**: 396. 1836.

WILCOX: Pond near Queensland, just on the edge of our territory, May 17, 1904 (*2207*). What is probably the same thing (for I collected it the next day along the same river near Millen) was seen from a train in the Ogeechee River swamp at or near Halcyondale, SCREVEN Co., June 4, 1901. Fl. April.

New Hampshire to Michigan in the glaciated region, south to Florida and Mississippi in the coastal plain.

C. **tenax** Chapm.; Dewey, Am. Jour. Sci. II. **19**: 254. 1855.

C. Chapmani Sartw.

Sand-hills; rare. TATTNALL, COFFEE. More common on the fall-line sand-hills in Richmond County, and known also from Pulaski County.

South Carolina to West Florida, in the coastal plain.

C. **venusta** Dewey, Am. Jour. Sci. **26**: 107, *pl. T. f. 62.* 1834,

TATTNALL: Bog at head of branch near Reidsville, April 27, 1904. WILCOX: With *C. alata* (see above). Fl. April. Also in Laurens County.

North Carolina to Florida.

C. **debilis** Mx., Fl. **2**: 172. 1803.

With *C. reniformis* at both stations mentioned above. Fl. April.

South Carolina to Florida and Louisiana.

C. **triceps** Mx., Fl. **2**: 170. 1803.

In swamps with the preceding. TATTNALL (*2152*), COFFEE (*2205*, an exceptionally slender form). Fl. April.

Eastern United States.

C. glaucescens Ell., Sk. 2:553. 1824.

Chiefly in branch-swamps. MONTGOMERY, TELFAIR, COFFEE, IRWIN, COLQUITT, THOMAS. Remarkable for its late flowering, June–July. Inland to Americus and coastward to Charlton County.

South Carolina to Florida and Mississippi, in the coastal plain.

C. sp. (See Bull. Torrey Club 32:460. 1905.)

Differs from the preceding in having its pistillate spikes on stouter mostly erect peduncles, and flowering regularly about three months earlier. It is not at all rare, and was doubtless known to southern botanists of a century ago, but it is almost impossible to decide if any of them have ever given it a tenable name, on account of the confusion in this particular group.

Cypress ponds principally. COFFEE, WILCOX, BERRIEN, and doubtless other counties. Seems to be pretty well distributed over the pine-barrens of Georgia.

C. macrokolea Steud., Syn. Pl. Cyp. 223. 1855.

What I took for this species was noted in cypress ponds in IRWIN (near Ocilla, July 15, 1902) and DECATUR (near Climax, Aug. 13, 1903). More study is needed to determine the specific limits of this and the two preceding.

Florida to Missouri (?) and Texas, in the coastal plain.

C. Walteriana Bailey, Bull. Torrey Club 20:429. 1893

C. striata Mx., Fl. 2:174. 1803. Not of Gilib., 1792.

In rather permanent ponds; not common. SCREVEN (*2090*), IRWIN. Fl. April. Inland to Dooly County and coastward to Effingham, but details of distribution imperfectly understood. See Bull Torrey Club 32:460. 1905.

New Jersey to Florida, in the pine-barrens.

C. squarrosa L., Sp. Pl. 973. 1753.

COFFEE: Rather dry swamp of Ocmulgee River near Barrow's Bluff, May 14, 1904 (*2204*). Fl. April. No other station seems to be known for it within two or three hundred miles. See Bull. Torrey Club 32:460. 1905.

Connecticut to Michigan, Georgia, and Texas (?).

C. bullata Schk., Riedgr. Nachtr. 85. *f. 166.* 1806.

Swamps of rivers rising north of our territory. TATTNALL: Ohoopee River swamp (*2155*); COFFEE: Ocmulgee River swamp opposite Lumber City, Sept. 11, 1903. Fl. spring. I have also collected it in the Ogeechee River swamp in Effingham County.

A glaciated region and coastal plain plant, ranging from New Hampshire to Pennsylvania and Georgia. See Rhodora **8**: 28-29. 1906.

C. turgescens Torr., Ann. Lyc. N. Y. **3**: 419. 1836.

Moist pine-barrens and edges of branch-swamps. BULLOCH (*2161*), COFFEE, WILCOX, BERRIEN. Fl. April. Not observed elsewhere.

North Carolina to Florida (?) and Louisiana, in the pine-barrens.

C. Elliottii Schw. & Torr., Ann. Lyc. N. Y. **1**: 357. 1825.

C. fulva Muhl., Gram. 246. 1817. Not of Good. 1794.

C. castanea Ell., Sk. **2**: 546. 1824. Not of Wahl. 1803.

Sphagnous bogs, etc.; rare. EMANUEL (*818*), COFFEE, BERRIEN (*2190*). Fl. April. I have not seen it elsewhere in the state, but both Muhlenberg's and Elliott's specimens came from Georgia, the latter from Chatham County.

North Carolina to Florida and Mississippi, in the pine-barrens.

C. intumescens Rudge, Trans. Linn. Soc. **7**: 97. *pl. 9. f. 3.* 1804.

BULLOCH: Branch-swamp near Pulaski, June 24, 1901 (*939*); COFFEE: Swamp of Ocmulgee River near Barrow's Bluff, May 14, 1904. Fl. April–May. More frequent in Middle Georgia.

Widely distributed in the Eastern United States.

C. folliculata L., Sp. Pl. 978. 1753.

TATTNALL: Swamp of Ohoopee River west of Reidsville, April 26, 1904, just past flowering (*2159*). The typical form not known elsewhere in Georgia.

Ranges northward to Canada.

Var. **australis** Bailey, Proc. Am. Acad. **22**: 62. 1886.

BULLOCH: Branch-swamp near Bloys, June 11, 1901 (*882*); COFFEE: Edge of swamp of Seventeen Mile Creek, July 19,

1902. Flowers later than the type, or at least retains its perigynia longer. Known also from Johnson and Sumter Counties (see Bull. Torrey Club **27** : 462. 1900.)

South Carolina to Florida and Louisiana, in the coastal plain.

SCLERIA Berg., Kgl. Sv. Acad. Handl. **26** : 142. 1765.

S. Michauxii Chapm., Fl. 532. 1860.

(?) *S. hirtella* Sw., Prodr. 19. 1788.

COLQUITT: Moist pine-barrens, several stations near Moultrie, September, 1902. With the typical form is often one with glabrous leaves, but apparently otherwise identical (*1646*). Fl. summer. Also in McIntosh, Glynn, and Charlton Counties in the flat country.

South Carolina to central Florida and Louisiana, in the pine-barrens.

S. verticillata Muhl.; Willd., Sp. Pl. **4** : 317. 1805.

COLQUITT: Moist pine-barrens, with the preceding and elsewhere; rare (*1647*). Also in Sumter and Early Counties, in the Lower Oligocene region.

Glaciated region and coastal plain of the Eastern United States, but with many gaps in its known range (not reported from Alabama, for instance). Also in Mexico and the West Indies, if it is all the same species.

S. pauciflora Muhl.; Willd., Sp. Pl. **4** : 318. 1805.

BULLOCH: Rather dry pine-barrens near Pulaski, June 24, 1901 (*940*). Grows also on dry slopes of the mountains of Northwest Georgia.

New Hampshire to Missouri, Cuba, and Texas; but not reported from Alabama.

S. glabra [Chapm.] Britton; Small, Fl. 200. 1903.

Sand-hills chiefly. EMANUEL (*807*), TATTNALL, MONTGOMERY, COFFEE (*1460*), WILCOX, DECATUR. Identity of my specimens still a little doubtful.

North Carolina to Florida and Mississippi, in the pine-barrens.

S. trichopoda Wright; Britton, Ann. N. Y. Acad. Sci. **3** : 232. 1883. (as syn.)

S. reticularis pubescens Britton, l. c.

Moist pine-barrens, etc. MONTGOMERY, DODGE, COFFEE, BER-

RIEN, DOOLY, COLQUITT (*1643*). Fl. summer. Somewhat variable in morphological characters, as well as in habitat. Extends coastward to Okefinokee Swamp, and inland to Pike County, Middle Georgia (see Bull. Torrey Club **30**: 294. 1903).

New Jersey(?) to the West Indies and Mexico.

S. triglomerata Mx., Fl. **2**: 168. 1803.

Hammocks and bluffs. MONTGOMERY, WILCOX. Fl. May–June. More common farther inland.

Widely distributed in the Eastern United States.

S. Baldwinii (Torr.) Steud., Syn. Pl. Cyp. 175. 1855.

Cypress ponds. TATTNALL (*998*), COFFEE, BERRIEN, COLQUITT. Fl. May–June. Inland to Pulaski, Sumter, and Early Counties, and coastward to Bryan, McIntosh, Ware, and Charlton.

South to central Florida and west to Texas, in the pine-barrens.

S. gracilis Ell., Sk. **2**: 557. 1824.

Shallow ponds, more rarely in moist pine-barrens. BULLOCH (*908*, *943*), TATTNALL, DODGE, IRWIN, DOOLY. Inland to Sumter, Lee, and Early Counties, and coastward to Charlton.

South Carolina to central Florida and Texas, in the pine-barrens. Also reported from Cuba.

RHYNCHOSPORA Vahl, Enum. **2**: 229. 1806.

(Original spelling *Rynchospora*).

R. inexpansa (Mx.) Vahl, Enum. **2**: 232. 1806.

Moist pine-barrens; rather rare. BULLOCH, MONTGOMERY, COFFEE. More common in the upper third of the coastal plain.

Virginia to Florida(?) and Louisiana, mostly in the coastal plain.

R. mixta Britton; Small, Fl. 197. 1903.

BULLOCH: In Big Lott's Creek near Bloys, June 27, 1901 (*974*).

Coastal plain of Georgia and Florida.

R. compressa Carey; Chapm., Fl. 525. 1860.

Moist pine-barrens; rare. COFFEE (*2200*), IRWIN (*1414*).

Reported also from Alabama, Florida, and Cuba.

R. cymosa (Willd.) Ell., Sk. 1 : 58. 1816. (excl. descr.)

BULLOCH: Rather dry sandy roadside near Bloys, June 11, 1901 (*880*); TATTNALL: Flat rocks near Ohoopee River, June 24, 1903. Fl. May–June. Extends inland to Middle Georgia.

New Jersey to Missouri, Florida, and Texas.

R. perplexa Britton; Small, Fl. 197. 1903.

IRWIN: Shallow pond near Fitzgerald, July 17, 1902. Also in mayhaw ponds in Sumter County. (Identity of my specimens somewhat uncertain.)

"North Carolina to Florida." Doubtless confined to the coastal plain.

R. Torreyana Gray, Ann. Lyc. N. Y. 3 : 197. 1835.

Intermediate and moist pine-barrens. BULLOCH (*884, 941*), TATTNALL, MONTGOMERY (*1868*). Fl. June. Coastward to Bryan County. Not seen southwest of the Ocmulgee and Altamaha Rivers.

New Jersey to Georgia, in the pine-barrens. (Reported from Alabama by Dr. Mohr, but the specimens so labeled in his herbarium are some other species.)

R. rariflora (Mx.) Ell., Sk. 1 : 58. 1816.

Intermediate and moist pine-barrens, not common. BULLOCH (*879*), TATTNALL, MONTGOMERY, WILCOX, BERRIEN. Fl. May–June. Inland to Washington and Sumter Counties.

North Carolina to central Florida and Texas, in the coastal plain.

R. Grayii Kunth, Enum. 2 : 539. 1837.

Dry pine-barrens and sand-hills; frequent in most of the counties. Fl. April–June. Inland to Richmond, Sumter, and Early Counties, and coastward to Cumberland Island.

North Carolina to central Florida and Texas, in the coastal plain.

R. dodecandra Baldw.; Gray, Ann. Lyc. N. Y. 3 : 207. 1835.

Hammocks and sand-hammocks. EMANUEL (*977*), TATTNALL, MONTGOMERY, COFFEE, WILCOX. Fl. May. Inland to the lime-sink region of Decatur County, and coastward to Bryan, McIntosh, and Wayne.

North Carolina to South Florida and Mississippi, in the pine-barrens and coastward.

R. fascicularis (Mx.) Vahl, Enum. **2**: 234. 1806.

Moist pine-barrens and margins of ponds; not common. COFFEE (*1440*), THOMAS (*1173*). Also in Okefinokee Swamp and east of there.

North Carolina to central Florida and Louisiana, in the pine-barrens.

R. distans (Mx.) Vahl. Enum. **2**: 235. 1806.

Mostly in intermediate pine-barrens, but usually in places which have been tampered with. BULLOCH (*878*), COFFEE (*684*, *1447*). Nos. *684* and *878* grew along roadsides, and the same plant occurs in the same way in Charlton County just east of Okefinokee Swamp. No. *1447*, from the margin of a sand-hill pond, looks a little different, and may not be identical with the others. The same thing occurs among the sand-hills of the Little Satilla River in Wayne County west of Hortense.

South Carolina to Florida, in the pine-barrens.

R. brachychaeta Sauv., An. Acad. Cienc. Habana, **8**: 85. 1871.

(?) *R. fascicularis trichoides* Chapm.

BULLOCH: Unfrequented road in rather dry pine-barrens, June 15, 1901 (*897*). Probably either a depauperate form of the preceding, or else not indigenous.

North Carolina (?) to Cuba.

R. Baldwinii Gray, Ann. Lyc. N. Y. **3**: 210. 1835.

Moist pine-barrens. BULLOCH (*852*), MONTGOMERY, COFFEE, IRWIN, BERRIEN, COLQUITT, DECATUR. Fl. May–June. Coastward to Effingham, Bryan, McIntosh, Ware, and Charlton Counties.

North Carolina to Florida and Mississippi, in the pine-barrens.

R. solitaria Harper, Bull. Torrey Club **28**: 468. 1901; **31**: 19. 1904.

Moist pine-barrens; rather inconspicuous. IRWIN, BERRIEN (*668*, type; *1677*, from same place), COLQUITT. Fl. May–Oct.

Not known elsewhere. (See Torreya **5**: 114. 1905.)

R. ciliaris (Mx.) Mohr, Contr. U. S. Nat. Herb. **6**:408. 1901.

R. ciliata Vahl, Enum. **2**: 235. 1806.

Normally in intermediate pine-barrens; not rare. BULLOCH (*887*), MONTGOMERY, APPLING, COFFEE (*683*, *701*), WILCOX, IRWIN, BERRIEN, WORTH, COLQUITT, DECATUR. Fl. May–Aug. Inland to Sumter, Lee, and Mitchell Counties, and coastward to Ware and Charlton.

North Carolina to central Florida and Mississippi, in the pine-barrens.

R. leptorhyncha Sauv., An. Acad. Cienc. Habana, **8**:84. 1871.

(Our specimens not quite typical. See Bull Torrey Club **33**: 231–232. 1906.)

COFFEE: Cypress ponds about three miles south of Douglas, July 24, 1902. Also in Pulaski and Sumter Counties in the Lower Oligocene region. Fl. June–July.

Also in western Cuba, where it was discovered.

R. filifolia Torr., Ann. Lyc. N. Y. **3**: 366. 1836.

COFFEE: Cypress ponds near Douglas (*1434*) and Chatterton. Fl. summer. Also in a similar place in Charlton County. Not seen elsewhere.

North Carolina to central Florida and Texas, in the pine-barrens.

R. gracilenta Gray, Ann. Lyc. N. Y. **3**: 216. 1835.

Moist pine-barrens; infrequent. TATTNALL, MONTGOMERY, COFFEE, IRWIN, Fl. June–July. Also in Sumter County.

New Jersey to northeastern Florida and Texas, in the coastal plain.

R. axillaris (Lam.) Britton, Bull. Torrey Club **15**: 104. 1888.

Cypress ponds, branch-swamps, etc.; common in most if not all of the counties in the pine-barren region of Georgia. Fl. May–July.

Long Island to central Florida, Arkansas, and Louisiana, in the coastal plain.

R. glomerata paniculata [Gray] Chapm., Fl. 528. 1860.

Branch-swamps, etc.; not common. MONTGOMERY, TELFAIR,

IRWIN, COLQUITT. Fl. June–July. More common farther inland.

Widely distributed in the Southeastern United States, mostly in the coastal plain.

R. alba macra Clarke; Britton, Trans. N. Y. Acad. Sci. **11**: 88. 1892.

Wet pine-barrens; rare. COFFEE (*716*), IRWIN. Fl. Sept.–Oct. Not seen elsewhere in the state.

South to Florida, west to Texas, in the pine-barrens.

R. semiplumosa Gray, Ann. Lyc. N. Y. **3**: 213. 1835.

Intermediate and moist pine-barrens; not rare. BULLOCH (*853*, *893*), EMANUEL, DODGE, COFFEE (*706*), WILCOX, IRWIN, BERRIEN, COLQUITT, DECATUR. Fl. May–July. Inland to Sumter and Lee Counties, coastward to Charlton.

South to Florida, west to Louisiana, in the pine-barrens.

R. plumosa Ell., Sk. **1**: 58. 1816.

Dry pine-barrens and rock outcrops; apparently rare. BULLOCH (*859*), TATTNALL (*2156*), COFFEE. Fl. April–June.

South Carolina to West Florida and Louisiana, in the pine-barrens.

R. oligantha Gray, Ann. Lyc. N. Y. **3**: 212. 1835.

Moist pine-barrens; inconspicuous. COFFEE, WILCOX, IRWIN, BERRIEN. Fl. May–June. Also in Sumter County.

North Carolina to northeastern Florida and Texas, in the pine-barrens.

R. Chapmani M. A. Curtis, Am. Jour. Sci. II. **7**: 409. 1849.

Moist pine-barrens, or sometimes along roadsides or in other unnatural places; rare. COFFEE, IRWIN (*1420*), DECATUR. Fl. July–Aug. Also in Bryan County.

North Carolina to northern Florida and Louisiana, in the pine-barrens.

R. pusilla Chapm. Fl. 528. 1860.

Moist or intermediate pine-barrens; rare. TATTNALL (*997*), COFFEE.

South to Florida and Cuba, west to Texas.

R. corniculata (Lam.) Gray, Ann. Lyc. N. Y. 3: 205. 1835.

Ceratoschœnus longirostris (Mx.) Torr., Ann. Lyc. N. Y. 3: 369. 1836.

Mostly in and near branch- and creek-swamps. APPLING, COFFEE, IRWIN, DOOLY, WORTH, COLQUITT, THOMAS. Fl. June–Aug. More common in some other parts of the pine-barrens, particularly in the flat country.

Delaware to Ohio, northern Florida, Missouri, and Texas, a rather anomalous distribution. Mostly in the coastal plain.

DICHROMENA Mx., Fl. 1:37. 1803.

D. latifolia Baldw.; Ell., Sk. 1 : 90. 1816.

Moist pine-barrens or oftener in ponds; frequent. TATTNALL (*1000*), TELFAIR, COFFEE, IRWIN, BERRIEN, DOOLY, WORTH, COLQUITT, THOMAS. Fl. May–July. Inland to Sumter County and coastward to McIntosh (where it was discovered) and Camden Counties.

Virginia (?) to central Florida and Texas, in the pine-barrens.

The flowers of this species and the next are presumably entomophilous, a rare character in the Cyperaceæ. (See page 60 of this work, also Hilgard, Geol. & Agric. Miss. 369. 1860.)

D. colorata (L.) Hitchcock, Rep. Mo. Bot. Gard. 4: 141. 1893.

BERRIEN: Low grounds southwest of Tifton, Sept. 29, 1902. (see p. 112.) Fl. May–June. Inland to Dooly, Lee, and Early Counties in the Lower Oligocene region and coastward to the islands, always in places where the Lafayette formation seems to be absent.

New Jersey to the West Indies, Tennessee (?), Texas, and South America.

STENOPHYLLUS Raf., Neogen. 4. 1825.

S. Warei (Torr.) Britton, Bull. Torrey Club 21 : 30. 1894.

Sand-hills. BULLOCH (*972*), EMANUEL, TATTNALL, MONTGOMERY (several stations), COFFEE (*1459*). Fl. July–Aug. Inland to the sand-hills opposite Dublin and Hawkinsville, and coastward to Bryan, Liberty, Wayne, and Lowndes Counties.

Previously reported only from Florida.

S. Floridanus Britton; Nash, Bull. Torrey Club **22** : 161. 1895. "Water Grass."

A common weed in cultivated fields, around dwellings, etc., nearly always on Columbia sand. Now pretty well distributed through the pine-barren region of Georgia, and inland at least as far as Houston County, but how and when it first appeared in the state, probably no one knows. It is scarcely visible before the middle of June, but after that it comes up rapidly, and flowers in July and August.

Otherwise known only from Florida. Certainly not indigenous in Georgia, and natural range and habitat still unknown. See Bull. Torrey Club **28** : 467. 1901.

S. ciliatifolius (Ell.) Mohr, Bull. Torrey Club **24** : 22. 1897.

Sand-hills chiefly. BULLOCH (*973*), TATTNALL, MONTGOMERY, DODGE, COFFEE (*696*), IRWIN, BERRIEN, COLQUITT. Fl. July–Sept. Also on the fall-line sand-hills (*A. Cuthbert*) and in the Lower Oligocene region. Less frequent coastward.

North Carolina to Florida and Texas in the coastal plain, mostly in the pine-barrens.

FIMBRISTYLIS Vahl, Enum. **2** : 285. 1806.

F. autumnalis (L.) R. & S., Syst. **2** : 97. 1817.

Trichelostylis autumnalis Chapm., Fl. 522. 1860.

Low grounds and swamps; apparently usually a weed. COFFEE, IRWIN, COLQUITT. Fl. summer. Pretty well scattered over the state; probably indigenous in Middle Georgia if anywhere.

Throughout the Eastern United States and tropical America, but natural range and habitat not fully understood.

F. LAXA Vahl, Enum. **2** : 292. 1806.

In a ditch in Moultrie, Aug. 22, 1903. Occurs in similar situations in Americus and Leslie, Sumter County, and on moist rocks in Middle Georgia, where it may be indigenous.

Pennsylvania to Missouri, Florida, and Texas. Also in the tropics.

F. puberula (Mx.) Vahl, Enum. **2** : 289. 1806.

Chiefly in intermediate pine-barrens; not abundant. BULLOCH

(*858*, *866*), EMANUEL, TATTNALL, MONTGOMERY, COFFEE, WILCOX, IRWIN, BERRIEN, COLQUITT. Fl. May–July. I have never observed it in salt marshes as Dr. Mohr did in Alabama (see Contr. U. S. Nat. Herb. **6**: 400. 1901).

South Carolina to Florida and Texas, in the pine-barrens.

ELEOCHARIS R. Br., Prodr. Fl. Nov. Holl. **1**: 224. 1810.

E. melanocarpa (Baldw.) Torr., Ann. Lyc. N. Y. **3**: 311. 1836.

Moist pine-barrens and sandy margins of ponds. BULLOCH (*910*), MONTGOMERY, DODGE (in accidental pond, not indigenous), COFFEE, WILCOX. Fl. April to July. Inland to Pulaski and Lee Counties and coastward to Bryan and Charlton. Originally discovered near Savannah.

Massachusetts to Indiana in the glaciated region, south to central Florida in the coastal plain. Also reported from the West Indies. (See Rhodora **7**: 72. 1905.)

For some morphological notes on this species see E. J. Hill, Bull. Torrey Club **25**: 392–394. *pl. 344.* 1898.

E. Baldwinii (Torr.) Chapm., Fl. 519. 1860.

Normally in intermediate pine-barrens, but most abundant in unfrequented roads and paths in the pine-barrens, where it forms a dense, close turf, often excluding all other vegetation for several square feet. Easily recognizable, even from a moving train, by its characteristic habit and color. APPLING, COFFEE (*685*, *1451* from sandy margin of a cypress pond), IRWIN, BERRIEN, THOMAS. Common in the flat country toward the coast, but never seen northwest of the Altamaha Grit escarpment, and rarely north of the Altamaha River.

Otherwise known only from Florida.

E. prolifera Torr., Ann. Lyc. N. Y. **3**: 316. 1836.

IRWIN: Shallow pond near Fitzgerald; THOMAS: Heard's Pond (therefore not indigenous); DECATUR: Cypress pond near Climax. More frequent in Sumter County.

North Carolina to Florida and Louisiana, in the coastal plain.

E. tuberculosa (Mx.) R. & S., Syst. **2**: 152. 1817.

Moist pine-barrens. BULLOCH, EMANUEL, TATTNALL, COFFEE,

WILCOX, BERRIEN, COLQUITT. Fl. April–June. Pretty widely distributed in South Georgia; also occurs in Meriwether County, Middle Georgia.

Massachusetts to Pennsylvania, Florida, Arkansas, and Texas, mostly in the coastal plain. (See Rhodora **7** : 72. 1905.)

E. bicolor Chapm., Fl. 517. 1860.

Moist pine-barrens; very inconspicuous. IRWIN: Near Fitzgerald, Oct. 4, 1902 (*1711*); COLQUITT: Near Moultrie, Sept. 24, 1902 (*1665*).

Known otherwise from the type-locality in Gadsden County, Florida, near the southwestern end of our region.

E. ochreata (Nees) Steud.

BULLOCH: Wet woods (imperfectly understood) near Bloys, June 26, 1901 (*952*). Associated with a few other species rarely seen elsewhere in the region.

Virginia to central Florida and Mississippi, in the coastal plain. Also in tropical America.

E. Robbinsii Oakes, Hovey's Mag. **7** : 178. 1841.

COFFEE: Sand-hill pond near Seventeen Mile Creek, July 30, 1902. Also in Pulaski, Sumter, and Lee Counties, in the Lower Oligocene region. (See Bull Torrey Club **30** : 323. 1903.)

Known from two or three localities in the pine-barrens of North Carolina and Florida. More common in the glaciated region from New Brunswick to Michigan. (See Rhodora **1** : 43, 204. 1899 **7** : 72. 1905.)

E. interstincta (Vahl) R. &. S. Syst. **2** : 148. 1817.

E. equisetoides (Ell.) Torr., Ann. Lyc. N. Y. **3** : 290. 1836.

Only in permanent ponds and therefore not properly belonging to our flora. TELFAIR: Accidental pond near Helena (see note under *Brasenia*), July 4, 1903; DECATUR: Pond along the escarpment (see p. 82) between Faceville and Recovery, Aug. 14, 1903. Occurs in several other places in South Georgia, both in natural and artificial ponds.

Massachusetts to Michigan in the glaciated region, south to central Florida and Mexico in the coastal plain. Also in the West Indies. See Rhodora **7** : 72. 1905.

SCIRPUS L., Sp. Pl. 47. 1753.

S. Eriophorum Mx., Fl. **1**: 33. 1803; Fernald, Proc. Am. Acad. **34** : 500. 1899.

Moist pine-barrens; rather rare. APPLING, WILCOX. Pretty well scattered over the state, but in most places as a weed in ditches and moist railroad cuts. In the coastal plain it is very apt to be found where the Lafayette formation has been artificially removed, exposing the underlying Tertiary strata.

New Jersey to northern Florida, Arkansas, and Texas, mostly in the coastal plain.

S. cylindricus [Torr.] Britton, Trans. N. Y. Acad. Sci. **11**: 79. 1892.

DECATUR: With *Eleocharis interstincta* (see above), abundant in that locality. It does not seem to occur actually within our limits. Elsewhere in South Georgia I have seen it in Stewart, Sumter, Decatur (Cane Water Pond), and Lowndes Counties, in permanent ponds. Fl. May-June.

Maryland to northern Florida and Louisiana, in the coastal plain.

FUIRENA Rottb., Descr. et Ic. 70. 1773.

F. squarrosa hispida [Ell.] Chapm., Fl. 514. 1860.

Moist pine-barrens. EMANUEL, TATTNALL, DODGE, COFFEE, WILCOX, BERRIEN (*665*), DOOLY, COLQUITT. Fl. June–Sept. Widely distributed in South Georgia, and known from a few places in Middle Georgia.

New York to Florida and Texas, mostly in the coastal plain.

F. breviseta Coville; Harper, Bull. Torrey Club **28**: 466. 1901.

Moist pine-barrens and around shallow ponds; not common. COFFEE, IRWIN, DOOLY. Fl. July–Sept. Inland to Sumter, Calhoun, and Early Counties in the Lower Oligocene region, and coastward to Liberty and Lowndes.

North Carolina to Florida and Texas, in the pine-barrens.

KYLLINGA Rottb., Descr. et Ic. 13. 1773.

K. pumila Mx., Fl. **1**: 28. 1803.

Wet woods; rare. BULLOCH (*953*), COLQUITT. Fl. June–Sept. More common farther inland, extending up into Northwest Georgia.

Widely distributed in the Eastern United States south of latitude 39°.

CYPERUS L., Sp. Pl. 44. 1753.

C. **echinatus** (Ell.) Wood, Class-Book 734. 1861.

Hammocks and sand-hammocks; rather rare. EMANUEL (*979*), MONTGOMERY, DODGE, COFFEE (*1455*.)

Widely distributed in the Southeastern United States, but natural range and habitat not well worked out.

Martindalei Britton, Bull. Torrey Club **15** : 98. 1888.

Sand-hills and dry pine-barrens. MONTGOMERY, COFFEE (*1462*), COLQUITT. Fl. summer.

Otherwise known only from the pine-barrens of West Florida and Alabama. *C. filiculmis Vahl*, a closely related species, is widely distributed in the Eastern United States.

C. **cylindricus** (Ell.) Britton, Bull. Torrey Club **6** : 316, 339. 1879.

Hammocks, rare. MONTGOMERY, COFFEE (*1454*). Our specimens are scarcely typical, and may represent a distinct species.

C. **ovularis** (Mx.) Torr., Ann Lyc. N. Y. **3**: 278. 1836.

BULLOCH: Dry pine-barrens near Bloys, June 27, 1901 (*960*). Not seen since, and possibly not indigenous. Grows also in Middle and Northwest Georgia.

New York to Missouri, Florida, and Texas.

C. **retrofractus** (L.) Torr.; Gray, Man. 519. 1848.

Sand-hills; not common. BERRIEN, COLQUITT. Fl. July–Aug. Occurs also in the upper third of the coastal plain, and in several places in Middle Georgia. See Bull. Torrey Club **30**: 321–322. 1903.

New Jersey to Florida, Arkansas, and Texas, mostly in the coastal plain.

C. **Haspan** L., Sp. Pl. 45. 1753.

In and near branch-swamps. BULLOCH, EMANUEL, TATTNALL, COFFEE, WILCOX, BERRIEN, DOOLY, WORTH, COLQUITT. Fl. June–Aug. Also in the upper and lower thirds of the coastal plain, and in Meriwether County (see Bull. Torrey Club **30** : 294. 1903).

Virginia to South Florida and Texas, mostly in the coastal plain. Also in the tropics (if it is all the same species).

C. pseudovegetus Steud., Syn. Pl. Cyp. 24. 1855.

Shallow ponds and other damp places; not common. TATTNALL, MONTGOMERY, BERRIEN. More common in the upper third of the coastal plain. Occasional in Northwest Georgia.

Delaware to Florida, Tennessee, Indian Territory, and Texas, mostly in the coastal plain.

C. COMPRESSUS L., Sp. Pl. 46. 1753.

A weed of fields and roadsides. COFFEE: Douglas (*675*); COLQUITT: Moultrie and Autreyville. Fl. summer. Scattered pretty well over the state, at least in the Palæozoic region and coastal plain.

Introduced from the tropics.

C. SQUARROSUS L., Cent. Pl. **2**: 26. 1756.

A diminutive weed, abundant along the streets of Douglas, in what was once flat pine-barrens (*674*). Also in similar places in Wayne, Charlton, and Clinch Counties, and reported from adjacent Florida.

Introduced from the tropics.

DULICHIUM Pers., Syn. **1**: 65. 1805.

D. arundinaceum (L.) Britton, Bull. Torrey Club **21**: 29. 1894.

Sphagnous bogs, creek-swamps, sand-hill ponds, etc. MONTGOMERY, COFFEE, BERRIEN, COLQUITT, DECATUR. Fl. July–Aug. Pretty well scattered over South Georgia, but never observed farther inland (*i. e.*, above the fall-line).

Nearly throughout the glaciated region and coastal plain of North America. Occurred in Europe in the Pleistocene period. (See Rhodora **7**: 72. 1905; **8**: 28. 1906.)

Anatomy and morphology discussed by Holm, Am. Jour. Sci. IV. **3**: 429–437. *f. 1–8.* 1897.

LIPOCARPHA R. Br., App. Tuckey Exp. Congo, 459. 1818.

L. MACULATA (Mx.) Torr., Ann. Lyc. N. Y. **3**: 288. 1836.

Moist roadsides and ditches. DOOLY: Near Cordele; IRWIN: Fitzgerald. Fl. June. Scattered over South Georgia, but not common.

Virginia to central Florida and Alabama in the coastal plain, but natural range and habitat unknown. Also in the West Indies.

The representation of Cyperaceæ in our territory is remarkable for the large number of species of *Rhynchospora* (27 being here enumerated), the small representation of *Scirpus* (only one normally belonging to the region, and that rare in the natural state and at the same time not a typical *Scirpus*), and the moderate number of *Carices* (16 species and a variety). In these respects the flora of the Altamaha Grit region probably resembles that of the tropics more than it does that of the glaciated region, which would not be the case with some other families.

GRAMINEÆ.

ARUNDINARIA Mx., Fl. 1: 73. 1803. REED.

A. tecta (Walt.) Muhl., Gram. 191. 1817.

Moist pine-barrens, mostly near branch-swamps; not common. IRWIN, BERRIEN (*2195*), DOOLY, COLQUITT. Fl. May.

The species of *Arundinaria* are very imperfectly understood, and it is not at all certain that this one is identified correctly, so it is scarcely worth while to attempt to give its whole range.

What may be another species occurs in some of the muddy swamps and rich woods.

HORDEUM L., Sp. Pl. 84. 1753.

H. NODOSUM L., Sp. Pl. ed. 2. 126. 1752.

Streets of Fitzgerald, May 17, 1904. Also in Athens (Middle Georgia), and northward and westward. Fl April.

Probably native of Europe.

FESTUCA L., Sp. Pl. 73. 1753.

F. OCTOFLORA Walt., Fl. Car. 81. 1788.

F. tenella Willd., Sp. Pl. 1: 419. 1797.

Sandy roadsides near Ohoopee, Fitzgerald, and elsewhere, Fl. April–May.

Widely distributed in the United States, probably introduced from the tropics.

UNIOLA L., Sp. Pl. 71. 1753.

U. latifolia Mx., Fl. 1 : 70. 1803.

MONTGOMERY: Stallings' Bluff on the Oconee River near Mount Vernon, June 29, 1903. More common in the upper third of the coastal plain, and in Middle Georgia.

Widely distributed in the Eastern United States between latitudes 30° and 40°.

Leaf-anatomy discussed by Holm, Bot. Gaz., **16** : 168–171. *pl. 15.* 1891.

U. laxa (L.) B. S. P., Prel. Cat. N. Y. 69. 1888; Scribn., Mem. Torrey Club **5** : 51. 1894.

COFFEE: Margins of creek-swamps, July, 1902; not common. Scattered over the state, but nowhere abundant.

New York to central Florida, Tennessee, and Texas.

MELICA L., Sp. Pl. 66. 1753.

M. mutica Walt., Fl. Car. 78. 1788.

WILCOX: Upper Seven Bluffs, May 17, 1904. Belongs more properly to the Eocene region of the coastal plain, and to Middle Georgia. Fl. March–April.

Widely distributed in the Eastern United States between latitudes 32° and 39°.

ERAGROSTIS Beauv., Agrost. 70. 1812.

(All our species weeds.)

E. AMABILIS (L.) Wight & Arn.; Hook. & Arn., Bot. Beechey 251. 1840. (Not *E. amabilis* Walt.)

COLQUITT: Moist roadsides, etc.; about half a dozen stations within a few miles of Moultrie. This species has a remarkably restricted range in the United States, being known only from COLQUITT, Thomas, and Brooks Counties, Georgia, and Jefferson and Suwanee Counties, Florida, all of which are within 100 miles of each other. (See Bull. Torrey Club **31** : 17. 1904.) How and when it was introduced is still a mystery.

Native of Asia.

E. CILIARIS (L.) Link, Hort. Berol. 1 : 192. 1827.

Streets of Ocilla, July 15, 1902. Occurs in similar situations in the Lower Oligocene region.

South Carolina to South Florida and Mississippi, in the coastal plain. Introduced from the tropics.

E SIMPLEX Scribn., Bull. Div. Agrost. U. S. Dept. Agr. 7, ed. 3. 250. 1900.

"*E. Brownei* Kunth"; Chapm., Fl. 664. 1883.

A common weed along railroads. TELFAIR, IRWIN, BERRIEN, DOOLY, WORTH, COLQUITT (*1656*), THOMAS, and doubtless other counties. (See Bull. Torrey Club **31**: 17. 1904.) Also in the flat country toward the coast, and in Florida.

Natural range and habitat unknown.

E. REFRACTA (Muhl.) Scribn., Mem. Torrey Club **5**: 49. 1894.

APPLING: Sandy roadside northeast of Prentiss, Sept. 12, 1903.

Delaware to central Florida and Texas, but natural range and habitat uncertain

TRIPLASIS Beauv., Agrost. 81. 1812.

T. Americana Beauv., l. c. *pl. 16. f. 10.*

Uralepis cornuta Ell., *Tricuspis cornuta* Gray, *Triplasis cornuta* Benth.

Sand-hills; inconspicuous and probably not common. MONTGOMERY, DODGE, BERRIEN, COLQUITT (*1659*). Fl. Sept.–Oct. Extends inland to the fall-line sand-hills of Richmond (*A. Cuthbert*) and Taylor Counties, and southeastward nearly to the coast.

North Carolina to central Florida and Louisiana, in the coastal plain.

TRIDENS R. & S., Syst. **2**[2]: 34. 1817.

TRICUSPIS Beauv., Agrost. 77. 1812. (Not of Pers.)

URALEPIS and WINDSORIA Nutt., 1818.

T. ambiguus (Ell.) Schult., Mant. **2**: 333. 1824.

Poa, Ell.; *Windsoria*, Nutt.; *Tricuspis*, Chapm.; *Triodia*, Vasey; *Sieglingia*, Kuntze.

Triodia Elliottii Bush, Trans. Acad. Sci. St. Louis **12**: 73. 1902.

Moist pine-barrens and shallow ponds; rather rare. BULLOCH, DODGE (*1979*), BERRIEN, COLQUITT. Fl. June–Sept. Also in Sumter and Charlton Counties. There are some peculiarities about its habitat which are not well understood.

It is likely to be found in the same kind of places as *Breweria aquatica* and *Kœllia hyssopifolia*, and with practice one can learn just about where to look for it.

South Carolina to northern Florida and Texas, in the pine-barrens.

ELEUSINE Gaert., Fr. & Sem. 1: 7. 1788.

E. INDICA (L.) Gaert., l. c. 8.

Roadsides, etc. APPLING (two stations), WORTH (Ashburn). More common in almost any other part of the state.

Introduced from the tropics.

CAMPULOSUS Desv., Bull. Soc. Philom. 2 : 189. 1810.

C. aromaticus (Walt.) Trin.; Steud., Nomencl. ed. 2, 272. 1841.

Moist pine-barrens; not abundant. BULLOCH (*898*), TATTNALL, MONTGOMERY, DODGE, COFFEE, WILCOX, IRWIN, BERRIEN, WORTH, COLQUITT, and probably in most of the other counties. Ranges throughout the pine-barren region of Georgia and a little farther inland, to Sandersville and Americus. Fl. May–Aug.

Virginia to central Florida and Louisiana, mostly in the pine-barrens.

CAPRIOLA Adans., Fam. 2: 31. 1763.

C. DACTYLON (L.) Kuntze, Rev. 2: 764. 1891. "BERMUDA GRASS."

Streets of Tifton, Sept. 27, 1902. Doubtless occurs in many other places, where I may have passed it without making a note of it. Common in Middle and Southwest Georgia, both as a valuable pasture and lawn grass and as a despised weed.

Introduced from the tropics.

DANTHONIA DC., Fl. France 3: 32. 1805.

D. sericea Nutt., Gen., 1: 71. 1818.

TATTNALL: Rock outcrops near Ohoopee River and Pendleton Creek, June, 1903; past flowering. More common in Middle Georgia.

Massachusetts to northern Florida and Arkansas.

SPOROBOLUS R. Br., Prodr. Fl. Nov. Holl. 1: 169. 1810.

S. Floridanus Chapm., Fl. 550. 1860.

Habitat variable, embracing rocks, shallow ponds, small

branch-swamps, moist and intermediate pine-barrens. TATTNALL, MONTGOMERY, APPLING, COFFEE, BERRIEN, COLQUITT. Fl. September. More abundant in Sumter and Mitchell Counties, in the Lower Oligocene region.

Known otherwise only from northern Florida.

For some notes on this species see Bull. Torrey Club **28**: 464–465. 1901.

S. teretifolius Harper, Bull. Torrey Club **33**: 229-231. *f. 1.* 1906.

Moist pine-barrens; not rare. DODGE, COFFEE (*677*), IRWIN, BERRIEN, DOOLY, COLQUITT (*1642* type). Fl. July–Sept.

Not known elsewhere.

S. Curtissii [Vasey] Small; Scribn., Bull. Div. Agrost. U. S. Dept. Agr. **7**: 142. *f. 124.* 1897. (The name was used by Kearney in Bull. Div. Agrost. **1**: 24. 1895, but in such a way as would hardly constitute publication.)

Intermediate pine-barrens and corresponding places in sand-hills; rare. MONTGOMERY, APPLING. Fl. Aug.–Sept. Also in the flat country, and in adjacent parts of Florida.

S. gracilis (Trin.) Merrill, Rhodora **4**: 48. 1902.

S. junceus (Mx.) Kunth, Rev. Gram. **1**: 68. 1835.

S. ejunicdus Nash; Britton, Manual, 106. 1901.

Dry pine-barrens and sand-hills; not abundant. MONTGOMERY, COFFEE, BERRIEN, COLQUITT. Fl. July–Sept. Also in various other parts of South Georgia.

Has a wide and rather anomalous distribution in the Eastern United States.

MUHLENBERGIA Schreb.

M. expansa (Poir.) Trin., Unifl. 193. 1824. (*fide* Merrill, Rhodora **4**: 143. 1902.

M. trichopodes (Ell.) Chapm., Fl. 553. 1860.

Two forms of this occur in our territory, but the differences between them are not easily described. One I have seen in dry or intermediate pine-barrens in APPLING, COFFEE, COLQUITT (*1641*) and Sumter Counties, and the other in moist pine-barrens in DODGE, BERRIEN, COLQUITT (*1667*) and McIntosh Counties. The moist pine-barren form is

handsomer and stouter than the other, with broader and straighter leaves, the bases of which when old finally split up into fibers as in many species of *Sisyrinchium*. A microscopic examination of the leaf shows at once the reason for this, and reveals certain differences in the form and arrangement of the vascular bundles, but whether these characters are constant enough to be of specific value I cannot say. It has not been customary to separate species of grasses by such minute leaf-characters, and furthermore it is not known at present which of the two forms is the type of the species. Both forms seem to flower at the same time, in August and September, and I have seen specimens of both from other states.

The species is said to range from South Carolina to northeastern Florida and Mexico.

The leaf-anatomy, apparently of the moist pine-barren form, has been described by Kearney in Contr. U. S. Nat. Herb. **5**: 288. 1900.

STIPA L., Sp. Pl. 78. 1753.

S. avenacea L., l. c.

TATTNALL: Sandy west bank of Ohoopee River; WILCOX: Upper Seven Bluffs. Fl. April–May. More common in Middle Georgia.

New York to Missouri, Florida, and Texas.

ARISTIDA L., Sp. Pl., 82. 1753.

A. spiciformis Ell., Sk. **1**: 141. 1816.

Rather dry (intermediate) flat pine-barrens, and corresponding places in sand-hills. APPLING, COFFEE (*686*), BERRIEN, COLQUITT, THOMAS. Fl. July–Sept. Never seen near the escarpment or northwest of it, or northeast of the Altamaha River, but common in all the counties east of those mentioned and south of the river, *i.e.*, in the flat country around Okefinokee Swamp.

South Carolina (?) to central Florida and Mississippi, in the pine-barrens.

For a morphological note see Bull. Torrey Club **28**: 464. 1901.

A. palustris [Chapm.] Vasey, Contr. U. S. Nat. Herb. **3**: 45. 1892.

Cypress and other ponds in the pine-barrens. COFFEE (*690*), IRWIN, BERRIEN, DOOLY, COLQUITT. Fl. September. Inland to Sumter, Lee and Early Counties in the Lower Oligocene region, and coastward to the vicinity of Okefinokee Swamp, but not known northeast of the Altamaha River.

South to central Florida and west to Louisiana, in the pine-barrens.

A. virgata Trin.; Spreng. Neue Entdeck. **2**: 60. 1821.

A. condensata Chapm., Bot. Gaz. **3**: 19. 1878.

A. Combsii Scribn. & Ball, Bull. Div. Agrost. U. S. Dept. Agr. 24: 43. *f. 17.* 1900.

MONTGOMERY: Sand-hills of Gum Swamp Creek (*1982*) and Little Ocmulgee River, Sept. 10, 1903. Inland to the fall-line sand-hills near Augusta (*A. Cuthbert*), and coastward to Liberty, McIntosh, and Wayne Counties.

Also in northern Florida.

A. stricta Mx., Fl. **1**: 41. 1803. "WIRE-GRASS."

Everywhere in dry pine-barrens; doubtless the most abundant vascular plant in our territory. Of little intrinsic value, but its abundance makes it of considerable economic importance, it being the principal food supply for countless thousands of cattle and sheep. Other uses are being discovered for it, such as its manufacture into matting.

Virginia (?) to central Florida and Louisiana, confined to the pine-barrens or nearly so. Also in the Bahamas (*Hitchcock*).

A. sp. (near *Mohrii*).

MONTGOMERY: Sand-hills of Little Ocmulgee River, Sept. 10, 1903 (*1988*). Grows in tufts which die out at the center as they grow at the edges, giving a sort of "fairy-ring" appearance.

CENCHRUS L., Sp. Pl. 1050. 1753.

C. TRIBULOIDES L., l. c.

BERRIEN: Brookfield, Sept. 27, 1902.

Widely distributed in the Eastern United States, probably introduced from the tropics.

PANICUM L., Sp. Pl. 55. 7

P. Currani Ashe, Jour. Elisha Mitchell Sci. Soc. **15** : 113. 1898.

BERRIEN: Rich woods (see p. 111) southwest of Tifton, Sept. 29, 1902. Also in similar situations in Brooks County, in the Upper Oligocene region.

Scattered over the Southeastern United States, but not very well known.

P. Ashei T. G. Pearson, Jour. Elisha Mitchell Sci. Soc. **15**: 35. 1898.

COFFEE: Sand-hills and hammock of Seventeen Mile Creek, July, 1902; rare (*1435*). Also on sandy river-banks in Middle Georgia.

Distribution not fully worked out.

P. scabriusculum Ell., Sk. **1** : 121. 1816.

Branch-swamps, etc.; not common. BULLOCH (*881*), EMANUEL, COFFEE, IRWIN. Fl. June. Inland to Sumter County and coastward to Charlton.

North Carolina to Florida (?) and Texas, in the coastal plain.

P. Tennesseense Ashe, Jour. Elisha Mitchell Sci. Soc. **15**: 52. 1898.

BERRIEN: Rich damp woods southwest of Tifton, Sept. 29, 1902 (*1689*).

"New York and Illinois to Tennessee and Florida" (*Small*).

P. longiligulatum Nash, Bull. Torrey Club **26** : 574. 1899.

BULLOCH: Branch-swamp near Bloys, June 10, 1901 (*839*).

Otherwise known only from Florida.

P. lucidum Ashe, Jour. Elisha Mitchell Sci. Soc. **15** : 47. 1898.

BULLOCH: Wet woods near Bloys, June 7, 1901 (*829*). Also in Clarke County, Middle Georgia.

New Jersey to Florida and Mississippi.

P. barbulatum Mx., Fl. **1** : 49. 1803.

MONTGOMERY: Stallings' Bluff on the Oconee River, June 29, 1903.

Widely distributed in the Eastern United States.

P. angustifolium Ell., Sk. **1**: 129. 1816.

BULLOCH: Dry pine-barrens near Bloys, June 7, 1901 (*828*). Doubtless grows elsewhere in our territory.

Virginia to Florida and Texas, mostly in the coastal plain.

P. Combsii Scribn. & Ball, Bull. Div. Agrost. U. S. Dept. Agr. 29: 42. *f. 16.* 1900.

COFFEE: Moist pine-barrens near Douglas, Sept 22, 1903 (*2014*). BERRIEN: Shallow pond near Tifton, Sept. 26, 1902 (*1679*).

Known otherwise only from West Florida.

P. virgatum L., Sp. Pl. 59. 1753.

WORTH: Low grounds east of Tyty, with *P. hemitomon*, Sept. 30, 1902. Scattered over South Georgia, in dry or wet places, but natural habitat uncertain.

Widely distributed in the Eastern United States.

P. COGNATUM Schult.

IRWIN: In Lafayette soil along railroad cuts, Cycloneta and southward, Oct. 2, 1902, beginning to flower (*1702*). Also in the Eocene region. Becomes a tumbleweed in late fall.

Said to range from South Carolina to Minnesota and Arizona, but natural range and habitat unknown.

P. verrucosum Muhl., Gram. 113. 1817.

P. debile Ell., Sk. 1: 129. 1816. (Not of Desf., 1800.)

Moist pine-barrens, branch-swamps, etc.; not common. IRWIN, BERRIEN, WORTH, COLQUITT. Fl. September. Also in Sumter County.

Massachusetts to central Florida and Louisiana, in the coastal plain.

P. stenodes Griseb., Fl. Brit. W. I. 547. 1864.

P. anceps strictum Chapm., Fl. 573. 1860. Not *P. strictum* R. Br.

Margins of ponds, particularly cypress and sand-hill ponds; not common. COFFEE, COLQUITT. Fl. summer. Inland to Sumter and Early Counties and coastward to Ware and Charlton.

South to South Florida and west to Texas, in the pine-barrens. Also reported from the West Indies and South America, but it is not certain that our plant is identical with the tropical one.

P. hemitomon Schult., Mant. 2 : 227. 1824. MAIDEN CANE.

Brachiaria digitarioides (Carpenter) Nash; Britton, Manual 77. 1901. (For other synonyms see Merrill, Circ. Div. Agrost. U. S. Dept. Agr. 35 : 5. 1901.)

Open branch-swamps and adjacent moist pine-barrens. COFFEE, WILCOX, IRWIN, DOOLY, WORTH. Fl. June. More abundant in some other parts of South Georgia, especially in Okefinokee Swamp.

Delaware to Florida and Texas, in the coastal plain.

P. melicarium Mx. Fl. 1 : 50. 1803.

Steinchisma hians (Ell.) Raf.; Seringe, Bull. Bot. Soc. Genev. 1 : 220. 1830. (*fide* Ind. Kew.)

Moist pine-barrens or oftener along damp sandy roadsides, perhaps not indigenous. BULLOCH (*838*), WILCOX, COLQUITT.

North Carolina to South Florida, Missouri, and Texas, in the coastal plain. Also in the tropics.

OPLISMENUS Beauv., Fl. Owar. et Benin 2 : 14. *pl. 68. f. 1.* 1807.

O. setarius (Lam.) R. & S., Syst. 2 : 484. 1817.

Panicum Nuttallianum Steud., Nomencl. ed. 2. 2: 260. 1841.

TELFAIR: Ocmulgee River swamp near Lumber City, Sept. 11, 1903. Widely distributed over the coastal plain of Georgia, but most frequent in the upper third. Fl. Aug.–Oct.

South Carolina to South Florida and Texas, nearly confined to the coastal plain, though a shade-loving species.

ECHINOCHLOA Beauv.

E. COLONA (L.) Link, Hort. Berol. 2 : 209. 1833.

Railroad yard, Tifton, Oct. 2, 1902. More common in the older cities of Georgia.

Widely distributed in the Southeastern United States, also in the tropics, where it doubtless originated.

ANTHÆNANTIA Beauv., Agrost. 48. 1812.

A. villosa (Mx.) Beauv., Agrost. Ill. 8. *pl. 10. f. 7.* 1812.

Dry pine-barrens and sand-hills. IRWIN, BERRIEN (*1686*), COLQUITT. Fl. Aug.–Oct. Also in Richmond (*A. Cuthbert*), Sumter, and Brooks Counties.

South Carolina to central Florida and Texas in the coastal plain, mostly in the pine-barrens.

A. rufa (Ell.) Schult. Mant. 2: 258. 1824.

Moist pine-barrens. DODGE, COFFEE, IRWIN, BERRIEN, DOOLY, WORTH, COLQUITT (*1651*). Fl. Aug.–Oct. Also in McIntosh County.

South Carolina to northeastern Florida, in the pine-barrens.

SYNTHERISMA Walt., Fl. Car. 76. 1788.

S. SANGUINALE (L.) CROP GRASS. CRAP GRASS. CRAB GRASS.

Chiefly in cultivated fields and around dwellings. DODGE, IRWIN, BERRIEN, and doubtless elsewhere where I have not taken the trouble to note it.

Common almost everywhere in the Eastern United States. Introduced from the tropics.

ANASTROPHUS Schlecht., Bot. Zeit. 8: 681. 1850.

A. COMPRESSUS (Sw.) Nash; Britton, Manual 75. 1901.

WORTH: Tyty, Sept. 30, 1902. Also near Union, Waycross, and doubtless many other places in South Georgia, always as a weed.

Introduced from the tropics.

A. paspaloides (Mx.) Nash; Britton, Manual 75. 1901.

TELFAIR: Ocmulgee River swamp near Lumber City. Scattered over South Georgia in damp places, but like several other of our plants which range southward to the tropics, its indigeneity is a little doubtful. Fl. summer.

North Carolina to Florida and Texas in the coastal plain. Also in the West Indies.

PASPALUM L., Syst. ed. 10, 2: 855. 1765.

P. præcox Walt., Fl. Car. 75. 1788.

BULLOCH: Moist pine-barrens near Bloys, June 15, 1901 (*900*).

South Carolina to central Florida and Texas, in the coastal plain.

P. Curtisianum Steud., Syn. Pl. Glum. 26. 1855.

Moist pine-barrens. COFFEE (*672*), IRWIN; BERRIEN, WORTH, COLQUITT. Fl. Sept.–Oct.

South Carolina to central Florida and Mississippi, in the pine-barrens.

SORGHASTRUM Nash; Britton, Manual 71. 1901.

S. secundum (Ell.) Nash; Small, Fl. 67. 1903. "WILD OATS."

"*Andropogon nutans* L.," J. E. Smith, in Abbot, Insects of Ga. 25. *pl. 13.* 1797.

Andropogon secundum Ell., Sk. 1: 580. 1821.

Sorghum secundum (Ell.) Chapm., Fl. 583. 1860.

Chrysopogon secundus (Ell.) Benth.; Vasey, Grasses U. S. 29. 1885.

Dry pine-barrens and sand-hills. APPLING, COFFEE (*719*), WILCOX, IRWIN, BERRIEN, DOOLY, WORTH, COLQUITT. Fl. Sept.–Oct. Doubtless grows in most of the other counties, but it is not recognizable when not in flower. Widely distributed over South Georgia, from the fall-line sand-hills of Richmond (*A. Cuthbert*) and Taylor (where Elliott discovered it) to the flat pine-barrens. See Bull. Torrey Club **28**: 463. 1901; **31**: 12. 1904.

Also reported from Florida as far down as Tampa, and doubtless grows in the coastal plain of South Carolina and Alabama as well.

S. nutans (L.) Nash; Small, Fl. 66, 1903.

Sorghum avenaceum (Mx.) Chapm., Fl. 583. 1860.

Dry pine-barrens. BERRIEN, COLQUITT (*1657*). Fl. Sept.–Oct.

Widely distributed in the Eastern United States, most common northward.

The three known species of this genus have been much confused, and it is difficult to identify them from most descriptions, because they all look about alike when pressed. But they are amply distinct in life, and were pretty well described by Dr. Chapman in the first edition of his Flora. The other species (*Sorghum nutans* Chapm., *Sorghastrum Linneanum* Nash) grows in many places in the upper third of the coastal plain of Georgia.

ANDROPOGON L., Sp. Pl. 1045. 1753.

A. furcatus Muhl.; Willd., Sp. Pl. **4**: 919. 1806.

Dry pine-barrens; not common. BERRIEN (*1685*), COLQUITT.

Fl. July–Sept. Also in the upper third of the coastal plain.
Widely distributed in the Eastern United States and Canada, often a weed in old fields in the North.
Anatomy of leaves and roots studied by W. E. Britton, Bull. Torrey Club **30** : 589, 599. *pl. 27e.* 1903.

? **A. Tracyi** Nash

Moist pine-barrens. IRWIN (abundant near Fitzgerald), BERRIEN (*1707*). Fl. Sept.–Oct.

A. Virginicus L., Sp. Pl. 1046. 1753.

Dry pine-barrens. SCREVEN, WILCOX, and doubtless elsewhere. Inland to the mountains, where it grows on dry sunny slopes. (See Torreya **5** : 56. 1905.)
Widely distributed in the Eastern United States, but probably not everywhere native.

A. Mohrii Hack.; Vasey, Contr. U. S. Nat. Herb. **3**: 11. 1892.

IRWIN: Moist pine-barrens near Fitzgerald, Oct. 4, 1902 (*1708*).
West to Mississippi, in the pine-barrens.

A. corymbosus [Chapm.] Nash; Britton, Manual 69. 1901 (without proper synonymy).

IRWIN: With the preceding (*1709*).
Virginia to Florida and Mississippi (?), in the coastal plain.

A. scoparius Mx., Fl. **1**: 57. 1803. BROOM SEDGE.

BERRIEN: Rather dry pine-barrens near Brookfield, Sept. 27, 1902 (*1684*). Possibly not indigenous.
Nearly all over North America, but usually as a weed.
Anatomy of leaves and roots described by W. E. Britton, Bull. Torrey Club, **30** : 588, 598–599. *pl. 27d.* 1903.

A. tener (Nees) Kunth, Rev. Gram. **2** : 565. *pl. 197.* 1832.

Dry and intermediate pine-barrens, usually where the Lafayette formation is at or near the surface; often abundant. Rarely on rocks. DODGE, TELFAIR, COFFEE, WILCOX, DOOLY, COLQUITT, THOMAS, DECATUR. Fl. summer. Inland to Sumter County and coastward at least to Lowndes.
West to Texas and south to Argentina.
This species is as good an illustration as any of the singular fact that nearly all the species in our territory which range

southward to the tropics have a noticeable tendency to become weeds. Some of course are known to have been introduced from the tropics, and occur with us only as weeds, but in the case of many which grow in natural habitats like this one there is an indefinable something about their appearance which leads one to suspect that they may not be indigenous The explanation of this is probably that a species which ranges through several degrees of latitude is usually capable of adjusting itself to different edaphic as well as climatic factors, and is therefore able to encroach on the territory of less tolerant species.

There is of course another category, of strictly native plants which are now supposed to have a very wide range but will be found on further study to be distinct from the related forms in the tropics. With practice one can usually distinguish the strictly native from the doubtfully native plants without much trouble.

ELIONURUS H. & B.; Willd., Sp. Pl. **4**: 941. 1806.
(Original spelling *Elyonurus*.)

E. tripsacoides H. & B., l. c.

Rottbœllia ciliata Nutt., Gen. **1**: 83. 1818.
Andropogon Nuttallii Chapm., Fl. 580. 1860.
BERRIEN: In those peculiar Lafayette-less spots already mentioned several times (see pp. 111, 112) southwest of Tifton. Collected once in a similar place near the southwestern corner of Camden County.
Also in East Florida, and in the tropics.

MANISURIS L., Mant. **2**: 164. 1771.

M. rugosa (Nutt.) Kuntze, Rev. **2**: 780. 1891.

Rottbœllia corrugata Baldw., Am. Jour. Sci. **1**: 355. 1819.
Moist pine-barrens, etc.; not common. DOOLY (*1959*), WORTH, BERRIEN, COLQUITT. Fl. Aug.–Sept. Not known farther inland, but extends coastward to Echols and Charlton Counties (originally discovered in Camden County).
South to Florida and west to Texas, in the pine-barrens. Also in Delaware.

M. Chapmani (Hack.) Nash; Small, Fl. 56, 1326. 1903.

"*Rottbœllia rugosa* Nutt." Chapm., Fl. 575. 1860.

Shallow ponds; rare. DOOLY, BERRIEN (*1680*), Fl. Aug.–Sept. More common in the Lower Oligocene region (see Bull. Torrey Club **27**: 425. 1900).

North Carolina to Florida and Alabama, in the pine-barrens.

M. cylindrica (Mx.) Kuntze, Rev. **2**: 779. 1891.

Dry pine-barrens; rare. BULLOCH (*835, 904*), TATTNALL. Fl. May–June. Also in Dooly, Sumter, and Lee Counties, in the Lower Oligocene region.

Also in northern Florida and Mississippi, in the pine-barrens.

ERIANTHUS Mx., Fl. **1**: 54. 1803.

E. strictus Baldw.; Ell., Sk. **1**: 39. 1816.

BERRIEN: Low grounds where the Lafayette formation is absent, southwest of Tifton, Sept. 29, 1902 (*1691*). Also in the Altamaha River swamp in McIntosh County. I have seen it somewhere else in South Georgia under similar conditions, when I did not know what it was and therefore could not very well make a note of it.

Georgia to Florida, Tennessee, and Texas, mostly in the coastal plain.

E. saccharoides Mx., Fl. **1**: 55. 1803.

Moist pine-barrens and small branch-swamps. WORTH, COLQUITT (*1662*), Fl. September.

New Jersey (?) to Florida and Texas (?), in the coastal plain.

E. brevibarbis Mx., l. c.

BERRIEN: Moist place at base of sand-hills of Little River southwest of Tifton, Sept. 29, 1902 (*1693*).

Delaware (?) to Florida and Texas (?), in the coastal plain.

ALISMACEÆ.

SAGITTARIA L., Sp. Pl. 993. 1753.

S. Mohrii J. G. Smith; Mohr, Bull. Torrey Club **24**: 19. *pl. 289*. 1897; Contr. U. S. Nat. Herb. **6**: 383. *pl. 3*. 1901.

Moist pine-barrens and open branch-swamps; also a little inclined to become a weed in ditches. EMANUEL (*994*),

MONTGOMERY, COFFEE (*718*), WILCOX, IRWIN, DOOLY. Fl. May–Sept. (See Bull. Torrey Club **28**: 462. 1901; **30**: 327. 1903).

Known otherwise only from Mobile County, Alabama.

(?) **S. graminea** Mx., Fl. **2** : 190. 1803.

Small ponds and branches; not common. BULLOCH (*950*), COFFEE. Fl. April–Aug.

ECHINODORUS Engelm.; Gray, Manual 460. 1848.

E. radicans (Nutt.) Engelm., l. c.

Swamps of rivers rising north of our territory. TATTNALL: Ohoopee River near Ohoopee; MONTGOMERY: Oconee River near Mount Vernon. Fl. summer. Like most of its associates, this is more frequent in the Lower Oligocene region.

North Carolina to Florida (Apalachicola), Illinois, and Texas, in the coastal plain. (Its occurrence in Florida only along the Apalachicola River is significant, for that is the only river in that state which rises north of the pine-barrens, as noted on p. 74.)

TYPHACEÆ.

SPARGANIUM L., Sp. Pl. 971. 1753.

S. androcladum [Engelm]. Morong, Bull. Torrey Club **15**: 78. 1888.

TELFAIR: Edge of swamp of Sugar Creek near McRae, July 4, 1903. DOOLY: Small pond near the Rock House, Sept. 1, 1903. More common farther inland.

Widely distributed in the Eastern United States.

CONIFERÆ.

PINUS L., Sp. Pl. 1000. 1753. PINES.

P. palustris Mill. (no. 14). Gard. Dict. ed. 8. 1768. "LONG-LEAF PINE."

P. australis Mx. f., Hist., Arb. Am. **1** : 64. *pl. 6.* 1810.

For illustrations see plates 2, 3, 5, 6, 18 and 26 of this volume.

In dry and intermediate pine-barrens everywhere in our territory, far more abundant than all the other trees

combined. In the region under consideration one can hardly get out of sight of this species, except in the depths of some swamp. It is equally abundant in all that part of Georgia underlaid by Oligocene or later rocks (*i. e.*, the "pine-barrens"), except in Okefinokee Swamp, where it is absent, and in the Upper Oligocene and maritime regions, where it is infrequent. It ranges nearly throughout the coastal plain (but is rare or wanting in most of the Eocene region), and near the western boundary of the state it extends inland to the mountains a little north of latitude 34° (see Torreya **5**: 55–60. 1905).

Extreme southern Virginia to central Florida and eastern Texas (see Torreya **3**: 122. 1903; Bray, Bull. Bureau Forestry, U. S. Dept. Agr. 47: 21–23, 53. *pl. 1, 6. map 1.* 1904). Confined to the coastal plain except in Georgia and Alabama as above noted. This is perhaps the most abundant and important tree in North America at the present time.

For a summary of almost everything known about this and the following species of *Pinus* see Mohr's *Timber Pines of the Southern United States*, especially the revised edition.

P. Elliottii Engelm., Trans. Acad. Sci. St. Louis **4**: 186. *pl. 1–3.* 1880. "SLASH PINE."

(?) *P. Caribæa* Morelet, Rev. Hort., de la Cote d'Or. 1851.

(?) *P. Bahamensis* Griseb., Fl. Brit. W. I. 503. 1864.

P. heterophylla Sudw., Bull. Torrey Club **20**: 45. 1893. (excl. syns.)

(See G. R. Shaw, Gard. Chron., March 19 and Aug. 6, 1904.)

For illustrations see plates 4, 5, 14 f. 2, and 17 f. 2.

Moist pine-barrens, branch-swamps, cypress ponds, etc. (never in mud or permanent water); common throughout, probably on every square mile of our territory, but far less abundant than the preceding. In Georgia its inland limit coincides with that of the pine-barrens (*i.e.*, with the boundary between the Eocene and Oligocene regions). From there to the coast it can be found almost everywhere, including Okefinokee Swamp and some if not most of the sea islands, where *P. palustris* is absent.

In many places it occurs as a second growth (known as "old-field slash-pine") in drier situations than its natural habitat. Perhaps its tendency to become a weed is correlated with the fact that it ranges southward to the tropics (see remarks under *Andropogon tener*, above).

South Carolina to South Florida and Louisiana, in the pine-barrens and coastward. Believed by some to be identical with a species growing in the Bahamas, Cuba, and perhaps other tropical regions. In Georgia it seems to be confined to the Columbia formation, but not quite to the Lafayette.

P. Tæda L., Sp. Pl. 1000. 1753. "SHORT-LEAF PINE."

In our territory almost confined to the swamps of creeks and small rivers. Has been noted in most of the counties. Fl. March–April.

Found in nearly all parts of the southeastern United States below 1000 feet above sea-level, and northward in and near the coastal plain to Delaware; but so commonly a weed in old fields that its natural habitat is difficult to determine in some sections.

P. serotina Mx., Fl. 2: 205. 1803. "BLACK PINE."

P. rigida serotina Loud., Encyc. Pl. 979. *f. 1824–1827.* 1829. *P. Tæda serotina* Wood, Class-Book 660. 1861. Illustrated in Plate 12, fig. 2.

Moist pine-barrens, sand-hill bogs and branch-swamps; common throughout, but not abundant. Noted in every county except Mitchell. Fl. March–April. Invariably associated with the Columbia formation, and can be found almost anywhere in South Georgia, including Okefinokee Swamp but excepting the lime-sink region and the sea islands. Its range terminates abruptly at the fall-line. Most abundant in the flat pine-barrens toward the coast.

Norfolk County, Virginia (see Torreya 3 : 122. 1903) to central and West Florida, strictly confined to the coastal plain.

P. echinata Mill. (no. 12), Gard. Dict. ed. 8. 1768.

P. mitis Mx., Fl. 2: 204. 1803. (SHORT-LEAF PINE.)

On bluffs along the muddy rivers; rare. MONTGOMERY, COFFEE, WILCOX. Occurs in a few widely separated localities

in the pine-barrens nearer the coast, but most abundant in the Eocene region (see Bull. Torrey Club **31**: 15. 1904) and thence northward to the mountains.

Long Island (?) to Missouri, northern Florida, and Texas.

P. glabra Walt., Fl. Car. 237. 1788. SPRUCE PINE. "WHITE PINE." (BOTTOM WHITE PINE.)

P. mitis paupera Wood, Class-Book 660. 1861.

Hammocks and bluffs; frequent but not abundant. SCREVEN, BULLOCH, EMANUEL, TATTNALL, MONTGOMERY, TELFAIR, COFFEE, WILCOX, THOMAS. Fl. April. Reaches a diameter of three feet in COFFEE County. Rarer toward the coast and commoner in the upper third of the coastal plain, but not quite reaching the fall-line. Its distribution in Georgia is very similar to that of *Magnolia grandiflora*, with which it is commonly associated.

South Carolina to northern Florida and southeastern Louisiana, in the coastal plain.

TAXODIUM L. C. Rich., Ann. Mus. Par. **16**: 278. 1810.

T. distichum (L.) L. C. Rich., l. c. 298. 1810. "CYPRESS."

For illustrations see pl. 9, f. 2 and pl. 27, f. 3.

River-swamps, almost confined to those streams which rise north of our territory and have eroded their channels through the superficial formations into the Tertiary strata. Occurs all along the Ohoopee, Oconee, Ocmulgee, Little Ocmulgee, and Ochlocknee Rivers. (The latter is a little anomalous in some respects among our supposed endemic streams, and if investigated it might be found to have some of its sources in the lime-sink region.) Fl. spring. In Georgia this species is confined to the coastal plain, and is most abundant in the upper third. The characters and distribution of this and the following species have been more fully discussed elsewhere (see Bull. Torrey Club **29**:383–399. 1902; **32**:105–115. 1905).

Delaware to Florida, Tennessee, Indiana, Missouri, and Texas, almost confined to the coastal plain.

A form apparently intermediate between this and the next grows in the Ogeechee, Little Ohoopee, Allapaha, and

Withlacoochee Rivers, and in Ochwalkee and Gum Swamp Creeks. (See Plate XXI, Fig. 1).

T. imbricarium [Nutt.] Harper, Bull. Torrey Club **29**: 383. 1902. "CYPRESS." (For illustrations see Bull. Torrey Club **32**: 109, 110, 113, 114. 1905; and plates 5, 6, 7, 10, 27 and 28 of this work.)

Common throughout in moist pine-barrens, branch-swamps, and cypress ponds, usually with *Pinus Elliottii*. Noted in every county in our territory; least abundant in SCREVEN, EMANUEL, MONTGOMERY, and the upper part of BULLOCH, where there are few or no cypress ponds and where this species does not grow in most of the branches as it does on the other side of the Altamaha River. Ranges throughout the pine-barrens of Georgia, including Okefinokee Swamp, and known from a few outlying stations in the upper fourth of the coastal plain.

Virginia (Dismal Swamp) to Florida and Mississippi, in the coastal plain.

JUNIPERUS L., Sp. Pl. 1038. 1753.

J. Virginiana L., Sp. Pl. 1039. 1753. "CEDAR."

TATTNALL: Along the Ohoopee River near Ohoopee; COFFEE: Along Ocmulgee River near Lumber City. More common in the upper third of the coastal plain and northward, particularly in the lime-sink and Palæozoic regions.

Widely distributed in the Eastern United States, but often as an escape from cultivation, so that it is difficult to determine its natural range accurately.

PTERIDOPHYTA.

ISOETACEÆ.

ISOETES L., Sp. Pl. 1100. 1753.

I. flaccida Shuttl.; Chapm., Fl. 602. 1860.

Branch-swamps. BULLOCH (*843*, *951*), COFFEE (*1429*), and doubtless elsewhere Known also from Laurens and Sumter Counties in the Lower Oligocene region, and from Florida. See Bull. Torrey Club **30**: 320. 1903

SELAGINELLACEÆ.

SELAGINELLA Beauv., Prodr. Ætheog. 101. 1805.

S. acanthonota Underw., Torreya **2**:172. 1902. (Plate XXVIII, Fig. 2).

Sand-hills along the tributaries of the Altamaha River. TATTNALL (*1852*), MONTGOMERY (*1987*). Extends down the Altamaha to Liberty County. (See Bull. Torrey Club **32**:152. *f.* *3*. 1905.)

A form not quite typical (*1957*) grows on rock outcrops in DOOLY County near Arabi.

North Carolina to Florida (?), in the pine-barrens.

S. arenicola Underw., Bull. Torrey Club **25**: 541. 1898.

TATTNALL: Rock outcrops near Ohoopee River (*1854*) and Pendleton Creek (*1860*), June, 1903. (See Fern Bull. **13**: 15. 1905.)

Previously known only from the lime-sink region of Decatur County, and from Lake County, Florida, on Columbia sand.

S. apus (L.) Spring, in Mart., Fl. Bras. **1**^{2}: 119. 1840.

BERRIEN: Damp woods west and southwest of Tifton, September, 1902. More common in the upper fourth of the coastal plain, and northward.

Widely distributed in the Eastern United States

LYCOPODIACEÆ.

LYCOPODIUM L., Sp. Pl. 1100. 1753.

L. Carolinianum L., Sp. Pl. 1104. 1753.

Moist pine-barrens; comparatively rare. EMANUEL, TATTNALL, COFFEE (*1428*), IRWIN, COLQUITT, DECATUR. Extends inland to a few miles beyond Americus, and coastward to Bryan and Charlton Counties, always on Columbia sand.

New Jersey to central Florida and Mississippi, in the coastal plain.

L. alopecuroides L., Sp. Pl. 1102. 1753.

Moist pine-barrens, sand-hill bogs, etc.; rather common. SCREVEN, BULLOCH, EMANUEL, TATTNALL, MONTGOMERY, TELFAIR. COFFEE, IRWIN, BERRIEN, COLQUITT, THOMAS,

DECATUR. Scattered nearly all over South Georgia, whereever there is wet Columbia sand.

Long Island to Florida and Mississippi, mostly in the coastal plain.

L. prostratum Harper, Bull. Torrey Club **33**: 229. 1906.

L. pinnatum [Chapm.] Lloyd & Underw., not Lam.

Moist pine-barrens; sometimes with the preceding but less common. COFFEE (*705*), IRWIN, BERRIEN, COLQUITT, DECATUR. I have seen it also in Meriwether, Sumter, Calhoun, Early, and Ware Counties, but never east of the Altamaha River and its tributaries.

Known also from the pine-barrens of West Florida and Alabama.

POLYPODIACEÆ.

DRYOPTERIS Adans.. Fam. 2: 20, 551. 1763.

D. Floridana (Hook.) Kuntze, Rev. **2**: 812. 1891.

BERRIEN: Rich damp woods near Tifton, Sept. 29, 1902 (*1687*). Known also in Sumter, Early, and Thomas (*Mrs. Taylor*) Counties, and a few stations in Florida and Alabama.

POLYSTICHUM Roth, Tent. Fl. Germ. 3: 69. 1800.

P. acrostichoides (Mx.) Schott, Gen. Fil. **2**:(no. 4). 1834.

Bluffs, etc., at or near our inland boundary (see pp. 102–106). MONTGOMERY (two stations), WILCOX, DOOLY. Associated with *Quercus alba* at each place, as is usually the case (see Fern Bull. **13**: 13. 1905).

Nearly throughout temperate Eastern North America.

ONOCLEA L. Sp. Pl. 1062. 1753.

O. sensibilis L., l. c.

MONTGOMERY: Oconee River swamp near Mount Vernon, June 30, 1903. Rarely nearer the coast, but frequent in the upper third of the coastal plain.

Widely distributed in the Eastern United States outside of Florida, but scarce in the pine-barren region.

LORINSERIA Presl., Epimel. Bot. 72. 1852.

L. areolata (L.) Presl, l. c.

Woodwardia angustifolia J. E. Smith. Mem. Acad. Tor. **5** : 411. 1793.

Wet woods and various other kinds of swamps. TATTNALL, MONTGOMERY, COFFEE, IRWIN, BERRIEN, COLQUITT. Probably grows in nearly every county in Georgia.

Nearly throughout the Eastern United States.

ANCHISTEA Presl, Epimel. Bot. 71. 1852.

A. Virginica (L.) Presl, l. c.

Woodwardia Virginica J. E. Smith. Mem. Acad. Tor. **5** : 412. 1793.

Moist pine-barrens, open branch-swamps, and various kinds of ponds. Noted in most of the counties. Ranges nearly throughout South Georgia, but never seen farther inland.

Nova Scotia to Michigan in the glaciated region, south to central Florida, Arkansas, and Texas, in the coastal plain. See Rhodora **7**: 71. 1905.

For references to some interesting literature on this species see Contr. U. S. Nat. Herb. **5**: 428 (footnote). 1901; Fern Bull. **13**: 10. 1905.

ASPLENIUM L., Sp. Pl. 1078. 1753.

A Filix-fœmina (L.) Bernh., Schrad. Neues Jour. Bot. **1**^{2}: 26. 1806.

Damp shaded places on bluffs; rare. MONTGOMERY: Stallings' Bluff; WILCOX: Upper Seven Bluffs. Scattered over South Georgia, but commoner in the upper half of the state.

Nearly throughout the north temperate zone in one form or another.

A. platyneuron (L.) Oakes; D. C. Eaton, Ferns N. A. **1**: 24. 1879.

Rich or damp woods; rare. With or near the preceding at both places, also at two stations in the upper part of BULLOCH *(956)*. Commoner in the upper fourth of the coastal plain, and still more so in Middle Georgia and northward.

Widely distributed in the Eastern United States.

PTERIDIUM Scop., Fl. Carn. 169. 1760.

P. aquilinum pseudocaudatum Clute, Fern Bull. **8**:39. 1900. (as syn.)

Chiefly in dry pine-barrens, less frequently in hammocks or on sand-hills or rocks. Common throughout, and often abundant.

Long Island to Florida and Texas.

MARGINARIA Bory, Dict. Class. Hist. Nat. **6** : 587. 1824.

M. polypodioides (L.) Tidestrom, Torreya **5** : 171. 1905.

Polypodium incanum Sw.

(For other synonyms see Tidestrom, l. c.)

On angiospermous trees in swamps and hammocks, also on projecting ledges of Altamaha Grit. TATTNALL, MONTGOMERY, DODGE, TELFAIR, COFFEE, BERRIEN. Scattered all over the state.

Widely distributed in the Southeastern United States and tropical America.

OSMUNDACEÆ.

OSMUNDA L., Sp. Pl. 1063. 1753.

O. spectabilis Willd. Sp. Pl. **5** : 98. 1810; Underw., Torreya **3** : 17. 1903.

In various kinds of swamps; rather rare. MONTGOMERY, IRWIN, BERRIEN, COLQUITT. Scattered over the state.

Nearly throughout temperate Eastern North America. Closely related to the European *O. regalis* L.

O. cinnamomea L., Sp. Pl. 1066. 1753.

Moist pine-barrens, branch-swamps, sand-hill bogs, etc.; common in most of the counties in our territory, and in all other parts of Georgia.

Throughout the Eastern United States.

OPHIOGLOSSACEÆ.

BOTRYCHIUM Sw., Schrad. Neues Jour. Bot. **1800**[2] : 110. 1801.

B. obliquum Muhl.; Willd., Sp. Pl. **5**: 63. 1810.

BERRIEN: Rich damp woods near Tifton, Sept. 29, 1902 More frequent in Middle Georgia, but nowhere abundant.

Widely distributed in the Eastern United States.

The treatment of the cellular cryptogams which constitute the remainder of this catalogue is necessarily less complete than that of the vascular plants. Their bibliography has not been as carefully investigated as has that of the higher plants since the nomenclature reforms of recent years, and consequently in some cases I have not been able to cite the place of publication correctly. For local distribution in Georgia in most cases I can only cite localities for specimens collected, for I am not sufficiently familiar with these plants to identify many of them in the field. Most of the mosses have been determined by Mrs. Elizabeth G. Britton, the hepatics by Miss Caroline C. Haynes, and the fungi by Dr. W. A. Murrill, and their assistance is hereby gratefully acknowledged.

Our knowledge of the general distribution of most of these plants is very fragmentary, for they are not usually mentioned in local floras, and consequently many of them are known only from the comparatively few stations where they have been collected. For this reason I have not attempted to give the total range in every case.

The number of cellular cryptogams known in the region will of course be considerably increased by future field work. It has been my custom while in the field to collect all bryophytes and woody fungi which I was not sure I had already, and there may not be over twice as many of these in the region as are listed here. The fleshy and parasitic fungi remain almost untouched, but it is not likely that they are very numerous, mainly for the same reasons noted by Kearney (Contr. U. S. Nat. Herb. **5**: 314. 1900) on the coast of North Carolina and Lloyd & Tracy (Bull. Torrey Club **28**: 81. 1901) on the coast of Mississippi. The lack of shade in the pine-barrens is unfavorable to the growth of a large number of cryptogams, from ferns down. Lichens I have never collected at all, but they are fairly abundant in hammocks and some other places.

BRYOPHYTA.

MUSCI.

SEMATOPHYLLUM Mitt., Jour. Linn. Soc. **8**: 5. 1864.

S. adnatum (Mx.) E. G. Britton, Bryologist **5**: 65. 1902.

On trunks of angiospermous trees. COFFEE (*1434b*). Also

in Sumter, Clinch, and Lowndes Counties, in other parts of the coastal plain.
Eastern United States

ISOPTERYGIUM Mitt.

I. micans (Sw.) E. G. Britton, Bryologist 5 : 67. 1902.
On damp decaying logs, in shade. COFFEE (*1449a*; also with *2046c*). Also in Sumter and Randolph Counties, in the upper third of the coastal plain.
New Jersey to Florida and Louisiana.

RHYNCHOSTEGIUM.

R. serrulatum (Hedw.) Jaeg. & Sauerb.
Habitat similar to that of the preceding. BULLOCH (*884c*, in part). Also in Randolph County.
Eastern North America.

THUIDIUM Br. & Sch.

T. sp.
BERRIEN: On roots of trees in non-alluvial swamp of Little River west of Tifton (*1700a*).

LEUCODON Schwaegr. Suppl. 2: 1. 1816.

L. julaceus minor
COFFEE: On bark of *Acer rubrum*, on bank of Seventeen Mile Creek (*1434a*).

HEDWIGIA Ehrh., Hann. Mag. 1781.

H. albicans viridis (Schimp.)
TATTNALL· On cliffs of Altamaha Grit near Pendleton Creek (*1860b*). This genus is rare in the coastal plain, on account of the scarcity of dry non-calcareous rocks which it prefers.

THELIA Sull.

T. asprella (Schimp.) Sull.
TATTNALL: On ledge of Altamaha Grit near Ohoopee River (*1857a*); COFFEE: On the ground in hammocks and sand-hammocks (*1434d*).
Eastern North America.

LESKEA Hedw.

L. denticulata Sull.

COLQUITT: On rough bark of old dead tree in Ocklocknee Creek swamp near Moultrie (*1673a*).

Middle and Southeastern United States.

FONTINALIS L.

F. flaccida R. & C., Bull. Soc. Bot. Belg. **27**[1]: 134. *pl. 9*; Bot. Gaz. **13**: 201. *pl. 19*. 1888.

TATTNALL: About low-water mark in rocky bed of Ohoopee River at the shoals west of Reidsville (*2151a*). I have collected what has been identified as the same thing in a cypress pond near Brunswick, a totally different habitat.

BRACHELYMA Schimp., Syn. Musc. Europ. ed. 2. 557. 1876.

B. robustum (Cardot) E. G. Britton, Bryologist **7**: 48. May 1904.

Cryphœadelphus robustus Cardot, Rev. Bryol. **31**: 8., 1904; Brotherus in Engler & Prantl, Nat. Pflanzenfam. **1**[3]: 731. 1905.

On trees and bushes subject to inundation, along all three classes of streams. TATTNALL: Ohoopee River west of Reidsville; COFFEE: Ocmulgee River at Barrow's Bluff; WILCOX: abundant along branches about five miles southeast of Rochelle. Our largest moss (*Sphagnum* excepted). Occurs also in Jefferson, Laurens, Pulaski, and Miller Counties, in the upper third of the coastal plain. (The species is based on material from the two counties last mentioned.)

Not known elsewhere.

TETRAPLODON Br. & Sch.

T. australis Sull. & Lesq. Mosses U. S. 53. 1856.

COLQUITT: On old cow dung in moist pine-barrens north of Moultrie, Sept. 24, 1902 (*1668a*). Prehistoric habitat unknown.

New Jersey to Florida, in the coastal plain.

RHIZOGONIUM Brid., Bryol. Univ. 2: 664. 1827.

R. spiniforme (Hedw.) Bruch, Flora **29**: 134. 1846.

COFFEE: Abundant on rotten logs and bases of trees in non-

alluvial swamp of Seventeen Mile Creek, February, 1904 (*2046a*). Also in Lowndes County.

Otherwise known only from Florida, Alabama (Mobile Co.), Louisiana, and some tropical countries.

FUNARIA Schreb.

F. hygrometrica (L.) Sibth., Fl. Oxon. 288. 1794.

BULLOCH: Wet woods near Bloys (*884c*, in part).

Cosmopolitan, but apparently not native everywhere.

PHYSCOMITRIUM Brid.

P. turbinatum (Mx.) Brid.

BULLOCH: With the preceding (*884a*). Also in Clayton County, Middle Georgia.

Throughout most of the United States.

SCHLOTHEIMIA Brid., Mant. Musc. 114. 1819.

S. Sullivantii C. Müll.

On trees, especially *Magnolias*, in hammocks and swamps.

MONTGOMERY, BERRIEN, COLQUITT. Also in Effingham and Brooks Counties, nearer the coast.

South Carolina to Florida and Louisiana, in the coastal plain.

PTYCHOMITRIUM Br. & Sch.

P. incurvum (Schwaegr.) Sull.

TATTNALL: Ledge of Altamaha Grit near Ohoopee River (*1857b*). Rare and inconspicuous.

Ranges northward to Canada.

GRIMMIA Ehrh., Beitr. 1: 168. 1787.

G. leucophæa Grev., Act. Soc. Wern. 4: *pl. 6*.

TATTNALL: Cliffs of Altamaha Grit near Ohoopee River (*1858a*) and Pendleton Creek, June, 1903. Probably not previously reported from the coastal plain. More common on granite outcrops in Middle Georgia.

North to New York and Ohio. Also in the Mediterranean region.

LEUCOBRYUM Hampe, Flora 20: 282. 1837.

L. glaucum (L.) Schimp.

TATTNALL: Cliffs of Altamaha Grit near Pendleton Creek,

June 26, 1903, Quite common in some other parts of Georgia, usually on bases of trees.

DICRANUM Hedw., Fund. **2**: 91. 1782.

D. **Bonjeani** DeNot.

BERRIEN: Sand-hills of Little River southwest of Tifton, Sept. 29, 1902. Also on Cumberland Island.

SPHAGNUM L.

S. **cuspidatum** [Ehrh.] Russ. & Warnst.

COFFEE: Non-alluvial swamp of Seventeen Mile Creek near Gaskin's Spring; abundant (*694a*, *2203a*, in fruit).

Eastern North America.

Var. **angustilimbatum** Warnst.

DODGE: Sand-hill pond in sand-hills of Gum Swamp Creek east of Eastman (*1976b*). Also in Okefinokee Swamp.

S. **Fitzgeraldi immersum** Warnst.

COFFEE: Shallow sand-hill pond in sand-hills of Satilla River south of Douglas (*1448a*).

S. **Garberi** L. & J.

DODGE: Edge of sand-hill pond east of Eastman (*1976c*).

S. **Harperi** Warnst., Bot. Centralb. Beihefte **16**: 250. 1904.

DODGE: With the preceding (*1976d*, type). Only locality known.

S. **tenerum** [Aust.] Warnst., Hedwigia **29**: 194. 1890.

BERRIEN: Sand-hill bog near Little River, Sept. 29, 1902. Also in Charlton County

S. **macrophyllum** Bernh.

Ponds, and swamps of endemic (*i. e.*, not muddy) streams. SCREVEN, COFFEE, IRWIN, COLQUITT. Also in pine-barren ponds in Sumter County.

New Jersey to Florida and Alabama, in the coastal plain.

S. **cymbifolium** Ehrh.

Non-alluvial swamps. BULLOCH (*829a*), COFFEE (*2203b*, in fruit). Also in Sumter and Decatur Counties and doubtless elsewhere in the state.

Cosmopolitan.

S. acutifolium Ehrh.

IRWIN: Swamp near Fitzgerald, July 16, 1902 (*1420a*).

HEPATICÆ.

ANTHOCEROS L., Sp. Pl. 1139. 1753.

A. Carolinianus Mx., Fl.

BULLOCH: Wet woods near Bloys (*884b*). Scattered over the state.

FRULLANIA Raddi, Atti Soc. Ital. Sci. Mod. 18: (9). 1818.

F. Kunzei Lehm. & Lindenb.

TATTNALL: Rocks near Ohoopee River (*1860a*). COFFEE: On bark of rotten log in non-alluvial swamp of Seventeen Mile Creek (*2046d*). Also in Walton, Sumter, and Lowndes Counties.

F. Caroliniana Sull.

COFFEE: With the preceding (*2046e*). Also in Sumter and McIntosh Counties.

ARCHILEJEUNEA [Spruce] Schiffn.

A. clypeata (Schw.) Schiffn.; Engler & Prantl, Nat. Pflanzenfam. 1^3: 130. 1893.

On trunks of angiospermous trees, mostly in swamps. COFFEE (*1434c*), COLQUITT (*1671a*). Also in Clarke, Whitfield, Echols, and Thomas Counties.

Middle and Southeastern United States.

MASTIGOLEJEUNEA.

M. auriculata (Hook. & Wils.) Schiffn., l. c. 129. 1893.

COLQUITT: On rough bark of old dead tree in swamp of Ochlocknee Creek near Moultrie (*1673b*). Also in Lowndes County.

Ranges west to Louisiana, in the coastal plain. Also in tropical America.

HARPALEJEUNEA.

H. ovata [Hook.) Schiffn., l. c. 127. 1893.

COFFEE: On bank of *Magnolia glauca* in non-alluvial swamp of Seventeen Mile Creek near Gaskin's Spring, February, 1904 (with *2046f*, *2047a*, and *2047b*).

Virginia to Georgia. Also in western Europe.

LEJEUNEA Lib.

L. Americana [Lindb.] Evans, Mem. Torrey Club **8**:154. 1902.

COFFEE: On bark of rotten log of *Gordonia* in non-alluvial swamp of Seventeen Mile Creek, Feb. 5, 1904 (*2046f*, in part).

North Carolina to Florida and Texas. Also in tropical America

PORELLA L., Sp. Pl. 1106. 1753.

P. pinnata L.

On bark of trees subject to inundation, along rivers and creeks. MONTGOMERY, COFFEE, COLQUITT. Scattered over the state.

Temperate Eastern North America. Also in Europe and Cuba (*Mohr*).

RADULA Dumort., Comm. Bot. 112. 1822.

R. sp. (undetermined).

COFFEE: On bark of rotten log of *Gordonia* in non-alluvial swamp of Seventeen Mile Creek near Gaskin's Spring, Feb. 5, 1904 (*2046c*).

SCAPANIA Dumort., Rec. d'Obs. Jung. 14. 1835.

S. nemorosa (L.) Dumort., l. c.

Swamps, bluffs, and rock outcrops; terrestrial. TATTNALL (*1860c*), MONTGOMERY (*1863c*), COLQUITT (*1674a*). Probably commoner in the upper parts of the state.

Europe and temperate North America.

BAZZANIA S. F. Gray, Nat. Arr. Brit. Pl. **1**:704. 1821.

B. trilobata (L.) S. F. Gray, l. c.

COFFEE: On rotten wood and bases of trees in non-alluvial swamp of Seventeen Mile Creek near Gaskin's Spring, Feb. 5, 1904 (*2046b*). Not seen elsewhere in Georgia.

Ranges north to New England. Also in Europe.

KANTIA S. F. Gray, Nat. Arr. Brit. Pl. **1**: 706. 1821.

K. Trichomanis (L.) S. F. Gray, l. c.

MONTGOMERY: Perpendicular clayey bank of ravine near Stallings' Bluff on the Oconee River (*1863b*). Also in Chattahoochee, Stewart, and Lowndes Counties, in similar situations.

ODONTOSCHISMA Dumort.

O. prostratum (Sw.) Trevis.

Chiefly on roots of trees in swamps (not muddy) and ravines. MONTGOMERY (*1863a*), COFFEE, IRWIN (*1415a*), BERRIEN (*1699a*), COLQUITT (*1674b*, in part). Also in Chattahoochee, Lowndes, and Clinch Counties, and in Okefinokee Swamp.

CEPHALOZIA Dumort., Rec. d'Obs. Jung. 18. 1835.

C. Virginiana Spruce.

COLQUITT: On small rotten log in swamp of Ochlocknee Creek near Moultrie (*1674b*, in part). Also in Lowndes County.

Virginia to Louisiana.

PLAGIOCHILA Dumort., Rec. d'Obs. Jung. 14. 1835.

P. Ludoviciana Sull

COFFEE: On bark of *Magnolia glauca* in non-alluvial swamp of Seventeen Mile Creek near Gaskin's Spring (*1448b*, *2047b*). Also in Clarke County.

West to Louisiana (*Mohr*).

P. undata Sull.

COFFEE: With the preceding (*1448c*, *2047a*). Also in Clarke, Chattahoochee, and Brooks Counties.

PALLAVICINIA S. F. Gray, Nat. Arr. Brit. Pl. **1**: 775. 1821.

P. Lyellii (Hook.)

On the ground in non-alluvial swamps, etc. COFFEE, BERRIEN, COLQUITT. Scattered over the state; one of our commonest hepatics.

MARCHANTIA L., Sp. Pl. 1137. 1753.

M. POLYMORPHA L., l. c.

TATTNALL: Fruiting abundantly along railroad near Ohoopee, in a place where some cross-ties had been recently burned, June 26, 1903. Natural habitat uncertain.

Cosmopolitan.

THALLOPHYTA.

FUNGI.

ASTRÆUS Morgan, Jour. Cin. Soc. Nat. Hist. **12**: 19. 1889

A. hygrometricus (Pers.) Morgan, l. c. 20.

Sand-hills. COFFEE DODGE Also in Lee County.

LENTINUS.

L. sp.

On rotten logs. WILCOX, COLQUITT. Also in Columbia County.

SCHIZOPHYLLUM Fr.

S. **commune** Fr.

COFFEE: On fallen trunk of *Magnolia glauca* in swamp of Seventeen Mile Creek near Gaskin's Spring (*694b*).

BOLETUS L.

B. Ananas M. A. Curtis, Am. Jour. Sci. II. **6**: 351. 1848.

COFFEE: Rather dry pine-barrens near Douglas, July 31, 1902. Also in Meriwether County.

ELFVINGIA Karst., Finlands Basidsv. 333. 1889.

E. fasciata (Sw.) Murrill, Bull. Torrey Club **30**: 298. 1903.

DODGE: On dying trunk of *Magnolia grandiflora* at base of sand-hills of Gum Swamp Creek east of Eastman (*1976a*). Also in Randolph County.

COLTRICIA S. F. Gray, Nat. Arr. Brit. Pl. **1**: 644. 1821.

C. parvula (Klotzsch) Murrill, Bull. Torrey Club **31**: 345. 1904.

Among ashes in dry pine-barrens. IRWIN, BERRIEN (*1696a*). Also in Bartow and Glynn Counties.

Pennsylvania to Georgia and Alabama.

INONOTUS Karst., Medd. Soc. Faun. & Fl. Fenn. **5**: 39. 1879.

I. amplectens Murrill, Bull. Torrey Club **31**: 600. 1904.

TELFAIR: On living twigs of *Asimina parviflora* in swamp of Ocmulgee River about a mile above Lumber City (*1990a*, type).

Not known elsewhere.

CORIOLUS Quel., Ench. Fung. 175. 1886; Murrill, Bull. Torrey Club **32**: 640. 1905.

C. versicolor (L.) Quel., l. c.

On dead trees and fallen logs. COFFEE (*693a*), DOOLY (*1962a*) Scattered over the state.

C. pargamenus (Fr.) Pat., Tax. Hymen. 94. 1900.

BULLOCH: On small dead tree in wet woods near Bloys (*884d*). Also in Bibb and Chattahoochee Counties.

ALGÆ

BATRACHOSPERMUM Roth.

B. vagum keratophytum (Bory) Sirdt.

(Determined by Dr. M. A. Howe.)

BERRIEN: Swift-flowing branch in small non-alluvial swamp or bog in sand-hills of Allapaha River about three miles east of Allapaha, May 5, 1904 (*2189a*).

SPIROGYRA.

S. sp. (according to Dr. T. E. Hazen).

COFFEE: Shallow cypress pond at outer edge of sand-hills of Seventeen Mile Creek near Chatterton July 29, 1902 (*1453a*).

MYXOMYCETES.

LYCOGALA Mx.

L. epidendrum (L.) Buxb

On rotten logs in swamps. MONTGOMERY, COLQUITT (*1676a*). Also in Brooks County, south of our limits.

STEMONITIS Gled.

S. sp.

BULLOCH: On pine stump in dry pine-barrens near Bloys (*984a*). Possibly not indigenous

Summary of the Catalogue.

The total number of families, genera, and species and varieties at present known to occur naturally in the Altamaha Grit region may be tabulated as follows:

Groups	Families	Genera	Species and varieties
Gamopetalæ	31	122	238
Archichlamydeæ	58	138	260
Monocotyledones	23	80	213
Gymnospermæ	1	3	9
Pteridophyta	6	14	19
Musci		20	28
Hepaticæ		15	17
Thallophyta		12	13
Total dicotyledons	89	260	498
Total angiosperms	112	340	711
Total spermatophytes	113	343	720
Total vascular plants	119	357	739
Total cellular cryptogams		47	58
Grand total		404	797

The 75 weeds which have already been listed separately (pages 114, 115) are not included in this enumeration, and all the following statistics will refer to native plants only, unless otherwise specified.

How nearly complete this catalogue is can only be conjectured. Considering the uniformity of the environmental conditions in different parts of the region, the open character of the forests, the conspicuousness of many of the species (at least 300 being large enough to be recognizable from a moving train), and the fact that I have passed through every county in the region more than once, it is not likely that more than 25 per cent. of the vascular plants (according to our present conceptions of species) have escaped me. The total number of spermatophytes probably does not exceed 1000, pteridophytes 25, and bryophytes 100. The number of thallophytes may ultimately run up to several hundred, but it is not likely that they are in the majority here as they are in most other parts of the world.

Two interesting things are brought out by the above table. The uniformity of the flora is shown by the small number of species; only 739 vascular plants known in 11,000 square miles. There are several states in the Union with a smaller area which contain nearly twice as many species. Second, the comparative newness of the flora is probably correlated with the large proportion of monocotyledons, which here constitute 30 per cent. of the total angiosperms. All parts of the coastal plain and glaciated region which have been sufficiently studied seem to have very nearly the same proportion, while in the Metamorphic and Palæozoic regions the monocotyledons average only about 25 per cent.[1]

Among the vascular plants it will be noticed that there are three times as many genera as families, and twice as many species as genera.

Largest families. The twelve largest families (each of which contains more than 1.5 per cent. of the total spermatophytic flora), and the number of native genera and species in each, are as follows: Compositæ (including Cichoriaceæ), 45 genera, 88 species; Cyperaceæ, 12 genera, 79 species; Gramineæ, 21 genera, 55 species; Leguminosæ (including Cæsalpiniaceæ and Mimosaceæ), 24 genera, 43 species; Scrophulariaceæ, 10 genera, 24 species; Ericaceæ (including Vacciniaceæ, Pyrolaceæ, and Clethraceæ), 12 genera, 23 species; Labiatæ, 9 genera, 18 species, Cupuliferæ, 2 genera, 16 species; Umbelliferæ, 7 genera, 14 species; Onagraceæ, 4 genera, 13 species; Euphorbiaceæ, 7 genera, 12 species; Orchidaceæ, 5 genera, 11 species.

The relations of these twelve largest families to the nineteen typical habitats previously described may be summarized as follows. In the table below, the number immediately following each family name indicates the number of native species, and the numbers in the columns the number represented in each habitat.

The last column, which does not strictly belong to this table, but is added here for convenience, shows the ratio of each family to the total number of spermatophytes.

[1] See *Torreya* 5: 207–210. 1905.

FAMILIES \ HABITATS	Rock outcrops	Dry pine-barrens	Intermediate do	Moist pine-barrens	Branch-swamps	Creek-swamps	Rivers of 2nd class	Muddy rivers	Cypress ponds	Shallower do	Escarpment do	Sand-hills	Intermediate do.	Sand-hill bogs	Non-alluvial swamps	Sand-hill ponds	Sand-hammocks	Hammocks	River-bluffs	Percent of all spermatophytes
Compositæ 88	5	25	20	23	5	1	1	4	7	0	1	16	3	1	—	1	1	1	1	12 2
Scrophulariaceæ 24	3	6	4	7	4	—	—	—	1	3	1	5	1	1	—	1	1	—	1	3.3
Labiatæ 18	1	5	2	5	3	—	—	2	1	3	—	5	—	1	—	—	3	3	—	2.5
Ericaceæ 23	2	5	7	9	3	5	—	—	2	—	1	6	6	4	2	4	4	4	2	3 2
Umbelliferæ 14	1	2	2	7	2	—	—	—	1	—	—	1	—	1	—	1	—	—	2	1 0
Onagraceæ 13	—	2	2	3	1	1	—	2	2	3	1	1	—	1	—	1	—	—	—	1 8
Euphorbiaceæ 12	1	6	1	—	—	—	1	1	1	—	—	7	—	—	—	—	1	2	1	1 7
Leguminosæ 43	1	23	6	—	2	—	3	2	—	—	—	22	—	1	—	—	—	3	4	6.0
Cupuliferæ 16	1	7	2	—	—	1	3	4	—	—	—	4	—	—	—	—	4	3	4	2 2
Orchidaceæ 11	1	—	2	9	—	1	—	—	—	—	—	—	—	5	1	—	—	2	—	1 5
Cyperaceæ 79	2	7	5	27	7	4	5	7	11	7	6	7	1	2	2	5	2	4	1	11 0
Gramineæ 55	3	9	6	16	4	1	—	2	2	7	—	7	1	2	—	2	—	1	4	7 6
All spermatophytes 720	40	135	97	182	74	52	44	56	50	60	26	132	31	50	21	36	35	61	65	

Table showing the numerical relations of the 12 largest families in the Altamaha Grit region to the 19 typical habitats.

Many interesting conclusions can be drawn from this table, but only a few of them will be mentioned here. It will be noticed first of all perhaps that Cyperaceæ occur in all the habitats, Compositæ in all but one, Ericaceæ in all but three, Gramineæ in all but four, Scrophulariaceæ in all but five, and Orchidaceæ in only six. It happens that intermediate pine-barrens is the only habitat in which all these families are represented.

If we add together the figures in each row and divide by the number of species in the corresponding family, we shall get a ratio representing roughly the adaptability to different habitats of the species in each family. In this respect Ericaceæ lead, with a ratio of 2.87, and Gramineæ come last, with 1.22. This is perhaps correlated with the fact that Gramineæ are more characteristic of old regions and Ericaceæ of new regions, in temperate Eastern North America at least. The ratio for the whole Altamaha Grit region was shown on page 108 to be about 1.68.

It will be noticed further that Orchidaceæ do not usually associate with Cupuliferæ, Leguminosæ, or Euphorbiaceæ, and that the habitats in which the three last-mentioned families do not occur contain nearly twice as many monocotyledons (see page 107) as those in which they do. This may indicate that these three families are comparatively highly specialized with respect to the orders to which they belong.

To eliminate from the above table differences due to the greater number of species in some habitats than in others, we should express the figures in each column in terms of their ratios to the number at the bottom of the column. Doing this, we would find that while Compositæ are most numerous in dry pine-barrens, they are most prominent in intermediate pine-barrens where they constitute 21% of the flora. Likewise Leguminosæ constitute about 17% of the flora of dry pine-barrens and sand-hills. Cyperaceæ are much more numerous in moist pine-barrens than anywhere else, but most prominent in cypress and escarpment ponds. Gramineæ, too, have nearly twice as many representatives in moist pine-barrens as in any other one habitat, but are more prominent in the shallow pine-

barren ponds. Euphorbiaceæ, like Leguminosæ, are most numerous and prominent in dry pine-barrens and on sand-hills.

Largest genera. The twenty-one largest genera in the Altamaha Grit region seem to be *Rhynchospora*, with 27 species; *Carex*, with 17; *Quercus*, 14; *Panicum*, 14; *Xyris*, 11; *Polygala*, 11; *Ludwigia*, 10; *Eupatorium*, 10; *Juncus*, 10· *Gerardia*, 8; *Asclepias*, 8; *Sabbatia*, 8; *Scleria*, 8; *Eleocharis*, 8; *Hypericum*, 7; *Andropogon*, 7; *Ilex*, 7; *Cyperus*, 7; *Laciniaria*, 6; *Rhexia*, 6; *Pinus*, 6.

The relations of these 21 genera to the 19 typical habitats are shown in the following table. The names of the genera are arranged systematically, each followed by the number of species just mentioned. Under each habitat is the number of species of each of these genera which it contains.

Pinus is represented in all the habitats, *Ilex* in all but three, and *Rhynchospora* in all but six. No *Quercus* ever associates with a *Juncus* or *Eleocharis* in our territory. *Xyris* is represented in every group in which *Quercus* is not, and associates with *Quercus* in only one.

Quercus would seem to be essentially an old and mesophytic genus. It does not occur in any habitat with over 35% of monocotyledons, but it does occur in all that have less than 20%. The proportion of monocotyledons in the nine groups in which it does occur is about 20%, and in the remaining ten, 37%. These figures would be just about reversed for *Juncus* and *Xyris*, and still more so for *Eleocharis*.

Sabbatia, *Ludwigia*, *Rhexia*, and *Hypericum*, characteristic dicotyledonous coastal plain genera, show a marked liking for the society of monocotyledons, while *Carex*, *Cyperus*, and *Panicum*, cosmopolitan monocotyledonous genera, lean a little the other way.

Commonest species. The 45 commonest species in the region, grouped according to size, and arranged as nearly as possible according to relative frequence in each group, are about as follows. (The left-hand columns are to be read first.)

TREES.

Pinus palustris	Pinus Elliottii
Quercus Catesbæi	Magnolia glauca
Nyssa biflora	Taxodium imbricarium

Genera \ Habitats	Rock outcrops	Dry pine-barrens	Intermediate do.	Moist pine-barrens	Branch-swamps	Creek-swamps	Rivers of 2nd class	Muddy Rivers	Cypress ponds	Shallower do.	Escarpment do.	Sand-hills	Intermediate do.	Sand-hill bogs	Non-alluvial swamps	Sand-hill ponds	Sand-hammocks	Hammocks	River-bluffs
Laciniaria 6	–	3	1	1	–	–	–	–	–	1	–	2	–	–	–	–	–	–	–
Eupatorium 10	–	3	3	3	1	–	–	1	–	1	–	1	–	–	–	–	–	–	–
Gerardia 8	–	2	2	5	1	–	–	–	–	1	–	1	–	–	–	–	–	–	–
Asclepias 8	–	3	2	1	1	1	–	1	–	–	–	3	–	–	–	–	–	–	1
Sabbatia 8	–	1	1	3	1	1	–	–	1	1	–	–	–	–	–	–	–	–	–
Ludwigia 10	–	–	2	3	1	1	–	2	2	2	1	–	–	1	–	1	–	–	–
Rhexia 6	–	–	3	5	–	–	–	–	1	2	–	–	1	1	–	1	–	–	–
Polygala 11	1	4	7	4	–	–	–	–	1	2	–	–	2	–	–	–	–	–	–
Hypericum 7	–	–	2	3	1	1	1	..	3	2	1	–	1	1	–	2	–	–	–
Ilex 7	1	1	1	1	2	1	–	1	1	1	–	–	1	2	1	1	2	3	1
Quercus 14	1	6	–	–	–	1	3	4	–	–	–	4	–	–	–	–	3	2	2
Juncus 10	–	–	1	4	2	–	–	–	1	2	–	–	2	1	–	1	–	–	–
Xyris 11	–	–	2	5	2	1	–	–	3	1	1	–	3	2	1	6	–	–	–
Carex 17	–	–	–	1	2	–	5	7	2	1	3	1	–	1	1	–	–	–	–
Scleria 8	–	1	1	4	1	–	–	–	2	1	–	1	–	–	–	–	–	1	1
Rhynchospora 27	2	2	2	13	3	2	–	–	5	2	–	1	1	–	–	2	1	1	–
Eleocharis 8	–	–	1	3	–	–	–	–	1	1	1	–	–	–	–	2	–	–	–
Cyperus 7	–	2	–	1	1	–	–	–	–	–	–	2	–	1	–	–	1	2	–
Panicum 14	–	1	–	4	2	–	–	–	1	3	–	–	–	1	–	1	–	1	1
Andropogon 7	1	1	–	3	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Pinus 6	2	1	3	2	2	3	2	2	1	1	1	1	1	2	2	1	1	2	3

Table showing relations of the 21 largest genera to the 18 typical habitats.

Pinus serotina	Quercus Margaretta
Nyssa Ogeche	Pinus Tæda
Quercus brevifolia	Acer rubrum
Liriodendron Tulipifera	Liquidambar Styraciflua

SHRUBS.

Ilex glabra	Pieris nitida
Pinckneya pubens	Cliftonia monophylla
Hypericum fasciculatum	Viburnum nudum
Cyrilla racemiflora	Ilex myrtifolia

HERBS.

Aristida stricta	Pteridium aquilinum pseudo-caudatum
Sarracenia flava	Pontederia cordata
Eriocaulon decangulare	Ludwigia pilosa
Chondrophora nudata	Stillingia sylvatica
Eriocaulon lineare	Baptisia lanceolata
Sarracenia minor	Baldwinia uniflora
Cracca Virginiana	Polygala cymosa
Eriogonum tomentosum	Baldwinia atropurpura
Kuhnistera pinnata	Baptisia perfoliata
Syngonanthus flavidulus	Mesadenia lanceolata virescens
Oxypolis filiformis	Marshallia graminifolia
Helianthus Radula	

The distinction between trees and shrubs is not a sharp one, and some of the above will be found in both categories a few pages farther on.

Notable absentees. From a phytogeographical standpoint the plants which do not occur in a given region are almost as important as those which do. I have elsewhere (Bull. Torrey Club **32**: 147. 1905) called attention to a number of species which are conspicuous by their absence, but it may not be out of place to repeat some of the same data here in a different way, with a considerable number of additions.

The following genera, each having three or more representatives in the Eastern United States and at least one in South Georgia, are wanting, or if present very rare, in the Altamaha Grit region.

Monarda	Asarum
Nama (Hydrolea)	Celtis
Cicuta	Boehmeria
Hydrocotyle	Populus
Svida (part of Cornus)	Uvularia
Jussiæa	Trillium
Lythrum	Homalocenchrus
Tilia	Potamogeton
Rosa	Typha
Hydrangea	Adiantum
Ranunculus	Phegopteris
Polygonum (in the broadest sense)	

The following genera are represented in the Eastern United States (including South Georgia) by a single widely distributed species which seems to be absent from the Altamaha Grit region.

Catalpa	Negundo
Phryma	Platanus
Epiphegus	Penthorum
Oxydendrum	Fagus
Decodon	Hexalectris
Sassafras	Medeola

The genera *Astcr*, *Solidago*, *Viola*, *Acer*, *Cratægus*, and *Scirpus* probably have fewer representatives in this region than in any other area of equal extent in temperate Eastern North America, with the possible exception of parts of Florida for *Aster* and *Viola* and some of the mountainous regions for *Scirpus*.

The following species, not included in the genera in the second list, are known in the upper and lower thirds of the coastal plain of Georgia, but not in the Altamaha Grit region, which is the middle third.

Polymnia Uvedalia L.
Plantago sparsiflora Mx.
Elephantopus elatus Bertol.
" Carolinianus Willd.
Monniera acuminata (Walt.) Kuntze.
Viburnum semitomentosum (Mx.) Rehder
Teucrium Nashii Kearney
Verbesina aristata (Ell.) Heller
Tubiflora Carolinensis (Walt.) Gmel.
Benzoin odoriferum Nees
Cicuta Curtissii C. & R.
Kalmia latifolia L.
Bumelia lycioides (L.) Gaert.
Rhexia Floridana Nash
Hypericum mutilum L.
Cassia Marilandica L.
Magnolia pyramidata Pursh
Dirca palustris L.
Nymphæa orbiculata Small
Arenaria lanuginosa (Mx.) Rohrb.
Quercus Virginiana Mill.
" minima [Sarg.] Small.
Boehmeria cylindrica (L.) Willd.
Juncus effusus L.
" megacephalus M. A. Curtis
Rhapidophyllum Hystrix (Pursh) W. & D.
Uvularia perfoliata L.
Rhynchospora miliacea (Lam.) Gray
" caduca Ell.

Scirpus fontinalis Harper
" validus Vahl
" Americanus Pers.
Eleocharis mutata (L.) R. & S.
Cyperus strigosus L.
Eustachys Floridana Chapm.
Panicum gibbum Ell.
" gymnocarpon Ell.
Sagittaria latifolia Willd.
Typha latifolia L.
Dryopteris patens (Sw.) Kuntze
Lycopodium Chapmani Underw.
Phegopteris hexagonoptera (Mx.) Fee

Several of these absentees grow in calcareous soil, or in open (i. e., not shaded) muddy places, or in permanent ponds, which have no counterpart in the region under consideration, and their absence is thus easily explained; but in other cases the reasons for this peculiar distribution are as yet obscure.

Structure and adaptations. All but a few of the flowering plants will fall into the classes of trees, shrubs, woody and herbaceous vines, and ordinary herbs. Among the trees the following are first-class forest trees, with trunks one to three feet in diameter and fifty to a hundred feet tall. (Evergreens are indicated by heavy type, as in the habitat lists.)

Nyssa uniflora
Persea pubescens
Gordonia Lasianthus
Liquidambar Styraciflua
Liriodendron Tulipifera
Magnolia grandiflora
" **glauca**
Quercus alba
" Michauxii
" lyrata
Quercus Phellos
Hicoria aquatica
Taxodium distichum
" imbricarium
Pinus palustris
" **Elliottii**
" **Tæda**
" **serotina**
" **glabra**

(Some species which have been noted only once in the region are omitted from this and the following lists.)

The following are small trees, rarely over a foot in diameter and forty feet tall in our territory.

Mohrodendron dipterum
Cornus florida
Nyssa biflora
Diospyros Virginiana
Acer rubrum
Ilex opaca
Gleditschia aquatica
Cercis Canadensis
Prunus umbellata
Cratægus Michauxii
" viridis
Magnolia glauca
Planera aquatica
Morus rubra
Quercus Margaretta
" **geminata**
" Catesbæi
" Marylandica
" **nigra**
" brevifolia
" **laurifolia**
Betula nigra

Ostrya Virginiana
Carpinus Caroliniana
Salix nigra
Taxodium imbricarium
Juniperus Virginiana

The following in our territory vary in size from shrubs to small trees

Osmanthus Americanus
Fraxinus Caroliniana
Bumelia lanuginosa
Diospyros Virginiana
Cholisma ferruginea
Nyssa Ogeche
Ilex myrtifolia
Cliftonia monophylla
Quercus geminata

The following are shrubs in our territory, though a few of them become arborescent elsewhere. To show at a glance what families the shrubs represent, and the number of species in each, the species in each family (where more than one) are connected by a brace.

Baccharis halimifolia
Chrysoma pauciflosculosa
Viburnum rufotomentosum
" obovatum
" nudum
" nitidum
Cephalanthus occidentalis
Pinckneya pubens
Clinopodium Carolinianum
" **coccineum**
Callicarpa Americana
Chionanthus Virginica
Adelia acuminata
Styrax grandifolia
" pulverulenta
Symplocos tinctoria
Bumelia reclinata
Vaccinium nitidum
Batodendron arboreum
Polycodium cæsium
" revolutum
Gaylussacia frondosa
" **dumosa**
Cholisma ligustrina
" **ferruginea fruticosa**
Pieris Mariana
" **nitida**
Leucothoë racemosa
" elongata
" **axillaris**
Kalmia hirsuta
Azalea viscosa
" nudiflora
" candida
Elliottia racemosa
Clethra alnifolia
Aralia spinosa
Benzoin melissæfolium
Malapoenna geniculata
Persea pubescens
Hypericum myrtifolium
" **fasciculatum**
" galioides pallidum
" **opacum**
Ascyrum stans
Ceanothus Americanus
" microphyllus
Æsculus Pavia
Euonymus Americanus
Ilex vomitoria
" ambigua
" **coriacea**
" **glabra**
" decidua
Cyrilla **racemiflora**
Rhus copallina
" aromatica
" Vernix
" Toxicodendron
Ceratiola ericoides
Stillingia aquatica
Sebastiana ligustrina
Amorpha fruticosa
" herbacea
Chrysobalanus oblongifolius
Cratægus apiifolia
" æstivalis
" uniflora
Amelanchier Canadensis
" sp.
Aronia arbutifolia
Rubus nigrobaccus

Liquidambar Styraciflua
Hamamelis Virginiana
Itea Virginica
Magnolia glauca
Asimina parviflora
" speciosa
" angustifolia
Polygonella Croomii

Phoradendron flavescens
Quercus pumila
Castanea pumila
" alnifolia
Alnus rugosa
Myrica Carolinensis
" cerifera
" pumila

It will be observed that a few species, notably *Magnolia glauca*, are included in more than one of the foregoing lists of woody plants, but this is done advisedly. *Magnolia glauca* occurs in our territory as one of the largest trees in non-alluvial creek-swamps, as a small tree in branch-swamps, and as a low shrub in moist pine-barrens; and these three forms seem perfectly distinct as far as size is concerned (but probably not in any other way.) In other words, there is no reason to suppose that the shrubs in the moist pine-barrens will ever become trees, or that the small trees in the branch-swamps will ever become large trees. Whether the shrubs ever come directly from the seeds of the trees, and vice versa, is another question. Similarly in the case of *Liquidambar*, there seem to be no intermediate stages between the shrubs in moist pine-barrens and the trees in river-swamps.

Our woody vines are as follows:

Lonicera sempervirens
Tecoma radicans
Bignonia crucigera
Trachelospermum difforme
Gelsemium sempervirens
Pieris phillyreifolia
Parthenocissus quinquefolia
Ampelopsis arborea
Vitis æstivalis
" rotundifolia

Berchemia scandens
Rhus radicans
Wistaria frutescens
Rubus trivialis
Decumaria barbara
Brunnichia cirrhosa
Smilax auriculata
" laurifolia
" Walteri

The herbaceous vines are somewhat more numerous, namely:

CLIMBING.

Mikania scandens
Cuscuta indecora
" compacta
Phaseolus polystachyus
Apios tuberosa
Galactia mollis
" regularis
Bradburya Virginiana
Clematis reticulata

TRAILING.

Mitchella repens
Breweria humistrata
" aquatica
Lespedeza repens
Meibomia Michauxii
" arenicola
Zornia bracteata
Morongia uncinata
Krameria secundiflora

Clematis crispa	Siphonychia Americana
Dioscorea villosa	Paronychia riparia
	Mayaca Aubleti
	Lycopodium pinnatum

About two-fifths of the vines are Leguminosæ. In the above list I have made no distinction between twiners and tendril-climbers ; and the distinction between climbing and trailing vines is not always a sharp one. *Galactia regularis* and perhaps others in the list may behave in either way, according to opportunity.

Among the vascular plants the only epiphytes are *Epidendrum*, *Dendropogon*, and *Polypodium;* and the only parasites *Conopholis* (which scarcely belongs to our flora), *Phoradendron*, and the two species of *Cuscuta*.

The remaining vascular plants, about 550 in number, are nearly all ordinary terrestrial herbs, most of them perennial.

Flowering and dissemination. I have not yet consolidated the data in regard to time of flowering, colors of flowers, and modes of dissemination for the whole flora as I have for the several habitat-groups, but some statistics of this kind for the four largest families, Compositæ, Leguminosæ, Cyperaceæ, and Gramineæ, may be of interest.

The phænological diagrams subjoined show in a striking manner how autumnal flowers predominate among the Compositæ and Gramineæ in our territory, just as in other parts of temperate Eastern North America. The diagram for Cyperaceæ shows little of interest except a decided "hump" in April, which is due almost entirely to the genus *Carex*. The other genera are mostly summer-flowering. The similarity of the Leguminosæ diagram to that for Cyperaceæ is striking, but at present unexplainable.

In the Compositæ there are more yellow flowers than any other kind, as we should expect from experience. 25 species have yellow flowers, 21 purple, 16 white, 10 yellow and dark purple, 4 cream, 4 blue and yellow, and the remaining 8 various colors more difficult to classify. Too little is known about the dissemination of our Compositæ. At least 39 species, and probably a majority of the whole 88, have wind-borne achenes, and three or four, if not more, are "tonoboles," but the remainder have not been sufficiently studied.

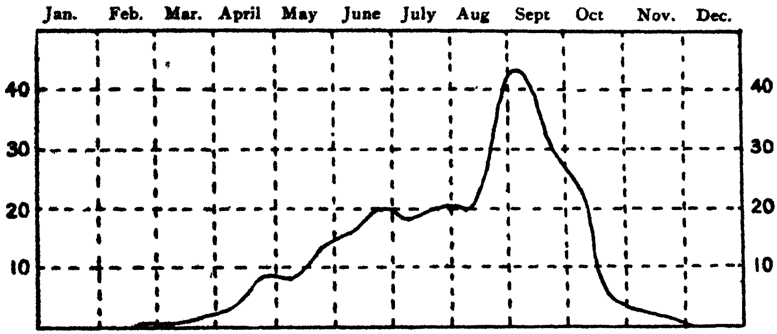

FIG. 18—Phænological diagram for 87 native species of Cichoriaceæ and Compositæ.

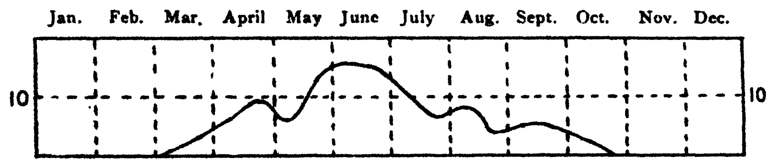

FIG. 19—Phænological diagram for 38 native species of Leguminosæ (including Cæsalpiniaceæ and Mimosaceæ,)

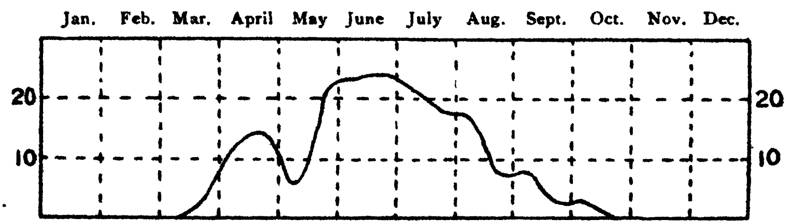

FIG. 20—Phænological diagram for 60 native species of Cyperaceæ.

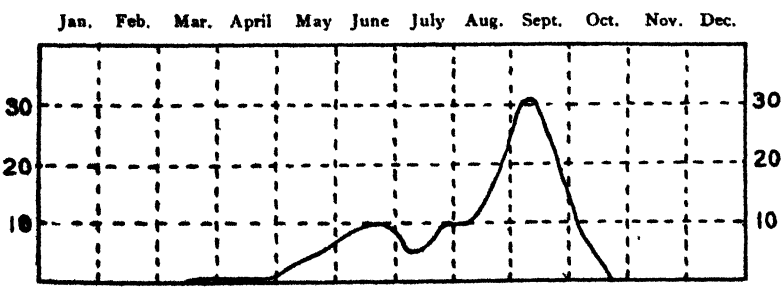

FIG. 21—Phænological diagram for 49 native species of Gramineæ.

In the Leguminosæ there are 10 purple flowers, 9 cream, 8 blue, 7 yellow, and 4 or 5 of other colors. For dissemination, in 9 species, if not more, the seeds are ejected by the sudden twisting of the valves of the legume as it splits open; 7 species have barbed fruits, 4 or 5 are tumbleweeds, and 2 (*Kuhnistera* and *Cercis*) probably have their legumes transported mainly by the wind.

The grasses and sedges seem to be all anemophilous, with the possible exception of the genus *Dichromena*. For dissemination the perigynia of most species of *Carex* seem to be adapted for floating and the barbed achenes of *Rhynchospora* and the reflexed spikelets of *Cyperus retrofractus* for attachment to animals. Among the grasses the seeds of a few species are carried by animals on their fur and a few more by the wind, but in most species the exact mode of dissemination is still unknown.

Geographical Affinities of the Flora.

Viewed as a whole, the ranges of the plants under discussion show in general a striking correspondence with the geological divisions of the continent as outlined near the beginning of this work. The following statistics are based on those native species whose ranges are pretty well known, only about 700 in number; but it is not likely that the percentages given here will be materially altered by future researches, for the finding of more species of restricted range in the region hereafter will doubtless be to a considerable extent counterbalanced by the extension at the same time of the known ranges of species already reported from the region.

About 60% of the species studied are confined to the coastal plain, or essentially so. Most of these (33% of the whole) are confined to the pine-barrens or lower three-fourths of the coastal plain (disregarding for the time being the extension of a few of them into the tropics). The majority of these endemic pine-barren species (nearly 17% of the total) are not known in Georgia farther inland than the Altamaha Grit escarpment. Accurate information as to their inland limits in the Carolinas, where no Altamaha Grit is known, is greatly to be desired.

Of the 40% not confined to the coastal plain, 31% (of the whole 700) grow almost anywhere in the Piedmont region of

Georgia, and many of them also reach the mountains and northern states. These widely distributed species are mostly plants of rock outcrops, dry pine-barrens, hammocks, river-swamps, and bluffs, as has already been pointed out in the discussions of these habitats, and are very largely dicotyledons. About 4.4% occur in the Piedmont region only in a few isolated localities, mainly in sandy bogs. The remainder, about 4.6%, grow in bogs and allied habitats in the glaciated region, but are absent or very rare in the Piedmont region and southern mountains.[1]

The above percentages may be tabulated as follows:

Reaching inland limit in Altamaha Grit region	17		
Reaching inland limit in Lower Oligocene region	16		
Confined to pine-barrens		33	
Inland to Cretaceous and Eocene regions only	27	27	
Confined to coastal plain			60
Common in Piedmont region	31		
Only in bogs in Piedmont region	4.4		
In glaciated region but rare in Piedmont	4.6		
Not confined to coastal plain		40	40
Total	100.0	100	100

The ranges may be correlated with arbitrary lines (parallels of latitude and political boundaries) as follows. A little more than half (53%) of the species are reported to range north of latitude 36° 30′ (and therefore into the so-called "Manual region"), mostly in the coastal plain of course, some along the coast, some in the Mississippi valley, and some on both sides of the mountains. About 5% range both northward into the Manual region and southward into the West Indies or Mexico (provided the tropical species are all identical with ours), and 2.7% range southward into the tropics but not northward. Most of the species common to the Altamaha Grit region and the West Indies, 50 or 60 in all, are such as are not confined to the Lafayette, a formation which is not definitely known outside of our coastal plain. In the other parts of the coastal plain of Georgia, where Lafayette-less areas are more common, the percentage of tropical species is doubtless greater, though I have not yet collected accurate statistics of this kind for any other region. Probably none of our native species reach Europe or

[1] See Rhodora, **7**: 09–80. April, 1905.

the Pacific coast, or if they do their identity or indigeneity in those parts is doubtful.

The following species and varieties, none of which seem to be very rare (each having been found in at least three counties), are not certainly known outside of the Altamaha Grit region.

Mesadenia lanceolata virescens Harper
Marshallia ramosa Beadle & Boynton
Pentstemon dissectus Ell.
Polygonella Croomii Chapm.
Rhynchospora solitaria Harper
Sporobolus teretifolius Harper

An equal number are known in the upper or lower thirds of the coastal plain, but have not yet been reported in any other state, viz.

Baldwinia atropurpurea Harper
Dicerandra odoratissima Harper
Zizia arenicola Rose
Viola denticulosa Pollard
Nymphæa fluviatilis Harper
Eriocaulon lineare Small

The following, founded on material from the Altamaha Grit region, are now known in other states.

Sabbatia gentianoides Ell.
Polygala Harperi Small
Arenaria brevifolia Nutt.
Siphonychia pauciflora Small
Juncus scirpoides compositus Harper

Bibliographic History.

Finally, the bibliographic history of the flora of the Altamaha Grit region since the time of Linnæus' *Species Plantarum* may be summarized very expeditiously by means of a couple of diagrams. These, like most of the foregoing statistics, refer to vascular plants only, the cellular cryptogams being omitted from the calculations for the reasons given on page 313.

In the first diagram the uppermost curve represents graphically the dates of description of our genera, beginning with 1753. The abscissas represent dates, as indicated at the base of the diagram, while the ordinates represent the number of genera which had been published up to any given date. In cases where the name originally given to a genus has been changed for any reason, only the original date is taken into consideration.

The curve for genera suggests the following points of interest. Just about half of our genera were known to Linnæus, doubtless

because the great majority of them are represented in the Carolinas, Virginia, and other regions which had been explored by botanists before his time. Comparatively few new genera in the list have been described since the time of Torrey & Gray, and none of these were based on new species. Michaux de-

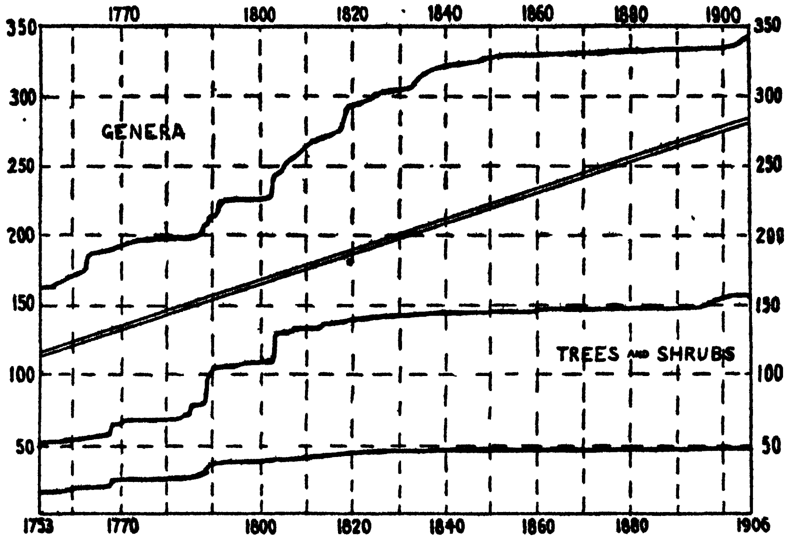

FIG. 22—Diagram showing dates of description of genera of vascular plants and species of trees and shrubs.

scribed (and doubtless discovered) more of our genera than any other one author since Linnæus, 15 being credited to him, most of these being based on single species which he discovered about 15 years before they were published. The following genera included in this work contain only species which have been described since Michaux's time and were presumably discovered in the 19th century.

Elionurus H. & B. 1806.
Triplasis Beauv. 1812.
Lophiola Ker 1813.
Elliottia Muhl. 1817.
Baldwinia Nutt. 1818.
Anantherix Nutt. 1818.
Tipularia Nutt. 1818.

Dicerandra Benth. (Ceranthera Ell. 1821).
Actinospermum Ell. 1823.
Lygodesmia Don 1829.
Warea Nutt. 1834.
Macranthera Torr. (Conradia Nutt. 1834).
Siphonychia T. & G. 1838.
Thysanella Gray 1845.
Phoradendron Nutt. 1848.
Gibbesia Small 1898.
Aldenella Greene 1900.

Sophronanthe (Benth. 1836), and perhaps one or two other genera, were based on species discovered in the 19th century but now include some of Michaux's or earlier species.

The middle curve in the first diagram is based on the dates of original description of our woody plants, and the lowest one gives the same data for trees alone, so the distance between the two curves corresponds to the number of shrubs. These show that just about one-third of our trees and shrubs were known to Linnæus, and that very few new ones have been described since the time of Elliott.

The second diagram is for all our species of vascular plants whose bibliographic history is known, about 700 in number. The upper curve represents original descriptions, as in the first diagram, and the lower is compiled from the dates on which the same species received their present names.

We see from this diagram that not quite one-fourth of our species were known to Linnæus (how many of these were originally described by him and how many by earlier authors I have not attempted to show), and that more than half of the whole number were unknown at the beginning of the 19th century. Michaux is the authority for more of them than any one else since Linnæus, having described over 100, or something like 14% of the whole. Walter is a close second, with 13% credited to him. It will be noticed also that more of our species have been described in the last fifteen years than in fifty years previous to that, and as many in the last ten years as in forty years previously. This is due partly to the narrowing conception of species and partly to the activity of Dr. Small and his contemporaries in field work.

The lower curve shows that over 14% of our plants still bear

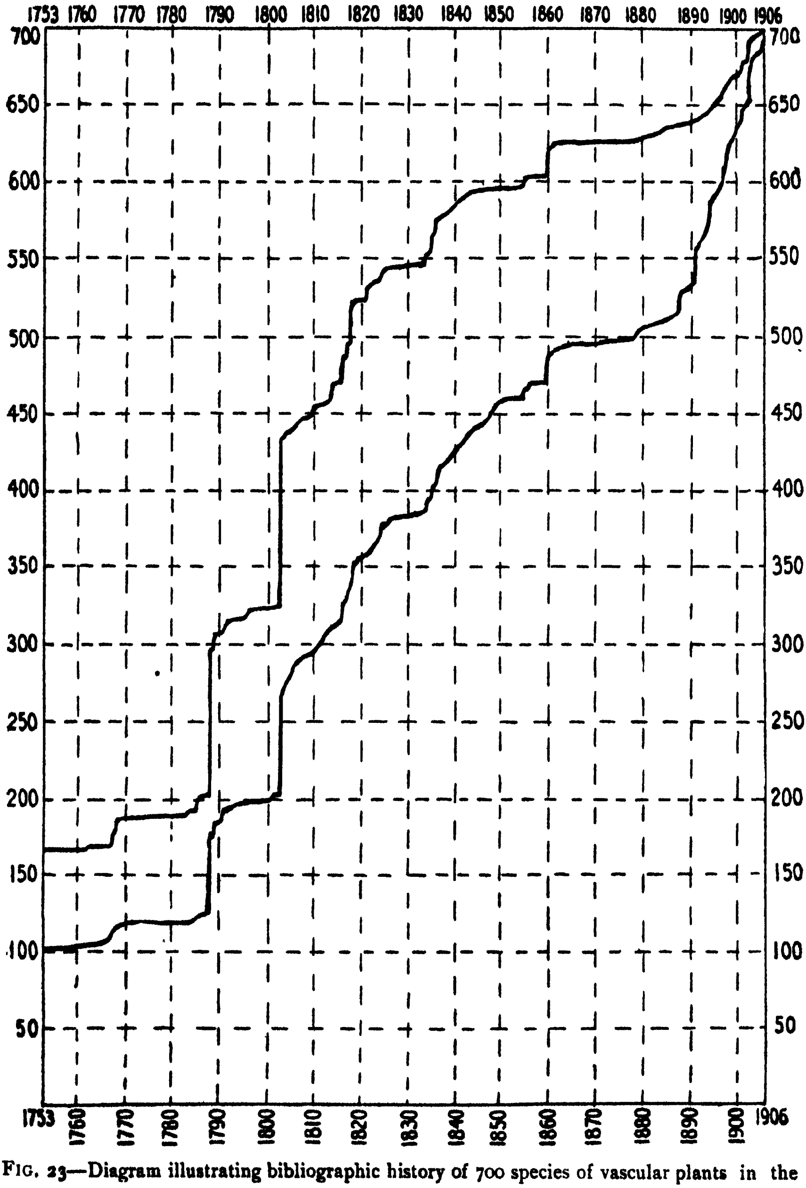

FIG. 23—Diagram illustrating bibliographic history of 700 species of vascular plants in the Altamaha Grit region.

the names that Linnæus gave them, and also illustrates the great activity of the nomenclature reformers in the last two decades. (The differences between two such curves are probably less for this region than they would be for almost any of the older-settled and more densely populated parts of the civilized world.)

CONCLUSIONS.

The most important points brought out in the foregoing pages seem to be the following:

The most satisfactory system of geographical classification of the vegetation of temperate Eastern North America is one based on geology.

The coastal plain, which is defined on strictly geological grounds, is probably the most distinct natural subdivision of temperate Eastern North America, differing notably from all other subdivisions in soil, topography, and geological history, and to a corresponding extent in its flora.

The Altamaha Grit region of Georgia is a centrally located and otherwise fairly typical portion of the coastal plain, in many respects homogenous and in some respects unique. Its boundaries are fairly well defined, and its flora differs perceptibly from that of adjacent regions.

The comparatively recent submergence of this region, which has been demonstrated by purely geological evidence, is borne out by the phytogeographical evidence herein set forth.

Owing to the comparative newness of the soil, and other considerations, open pine forests which give little shade are eminently characteristic of the region. With this state of affairs are correlated marked adaptations for reduction of transpiration in most of the plants inhabiting the region.

Similar types of soil and topography recur in all parts of the region, the climate is essentially uniform throughout, and the final details of plant distribution seem to be governed mainly by the amount of water in the soil—which in turn depends on topography—and by variations in the thickness of the mantle of Columbia sand.

All natural features of this region seem remarkably stable,

and any changes which may be taking place in the flora through natural causes must be extremely slow. The changes due to civilization have hitherto been much less marked than in most other parts of temperate Eastern North America

The species indigenous to the region are in general rather restricted in range, most of them being confined to the coastal plain, as far as known, and about one-third of them to the pine-barren portion of the coastal plain. A few range southward into the tropics (and most of these are quite variable in habitat), but probably none cross the Atlantic Ocean or the Great Plains. As a rule the most widely distributed species of vascular plants occupy habitats which are likewise widely distributed in Eastern North America, and belong to taxonomic groups relatively high in the scale.

As a whole the species composing this flora were mostly made known to science during the nineteenth century. But the woody plants have been known relatively much longer than the herbs, and the trees somewhat longer than the shrubs.

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1. Works in which the plants or other natural features of the Altamaha Grit region are described or mentioned (though in most of these no distinction is made between the region under consideration and those adjoining it). Arranged chronologically.

1797. **Abbot, John** The natural history of the rarer lepidopterous insects of Georgia. Including . . . the plants on which they feed. Edited by **J. E. Smith,** who wrote the descriptions of new species. Folio. 104 plates, with text. London.

Some if not most of the plants figured in this work are believed to have come from the northeastern portion of the Altamaha Grit region.

1817. **Elliott, Stephen.** Sketch of the botany of South Carolina and Georgia. Vol. 1. Charleston, 1816–1821.

Contains on page 286 the original description of *Sabbatia gentianoides* from Bulloch County. Several plants described as having been collected near Louisville by James Jackson may have also come from the Altamaha Grit region, as has been pointed out elsewhere.

1833 (?). **Nuttall, Thomas.** Description of a new species of *Sarracenia*. Trans. Am. Phil. Soc. **4**: 49–51. *pl. 1.*

Mentions its occurrence in Tattnall County. See Torreya **4**: 140. 1904.

1849. **White, George.** Statistics of the State of Georgia. 624 + 77 pp. and map. Savannah.

1855. **White, George.** Historical Collections of Georgia. 745 pp New York.

The most valuable features of these two works are the detailed descriptions of the counties. The supplement of the former contains among other things an alleged state flora, but as no localities are given for any of the species it has no obvious connection with that part of the state under consideration.

1876. **Janes, Thomas P.** Handbook of Georgia. vii + 256 pp. and map. Atlanta (published by the state agricultural department).

A descriptive work, somewhat similar in scope to the preceding Contains a list of woody plants, prepared by State Geologist **George Little,** but there is no evidence that any of these were observed in the Altamaha Grit region.

1881. **Hilgard, E. W.** The later Tertiary of the Gulf of Mexico Am. Jour. Sci. III. **22**:58–65 *pl. 3* (map).

The map shows an area of "Miocene (?) sandstone" in Georgia, corresponding approximately with the present known area of the Altamaha Grit, but there is no reference to it in the text. It was probably inserted on the authority of Dr. Loughridge (see next title).

1884. **Loughridge, R. H.** Report on the cotton production of the state of Georgia. Tenth Census U. S., **6**:259–450. *Map.*

A valuable compendium of the geological, geographical, and agricultural features of the state, which has scarcely been surpassed since The boundaries of the Altamaha Grit are located fairly accurately, except toward the west, and some outcrops of the rock are described. A bottomless "lime-sink" (see page 24 of this work) is mentioned in the description of Bulloch County.

1885. **Henderson, J. T.** The Commonwealth of Georgia. pp. i–viii, 3–184, 184a, 184b, 185–379. 15 colored double-page maps and 13 text figures. Atlanta. (Constitutes part 2 of vol. 11 of Publications of Georgia Department of Agriculture.)

This also contains many notes on the geology, geography, and agriculture of the state, largely copied from the preceding.

1892. **Dall, W. H., & Harris, G. D.** Correlation papers.—Neocene. Bull. 84, U. S. Geol. Surv.

Altamaha Grit described on pages 81 and 82, with references to some previous literature on the subject.

1893. **Foerste, Aug. F.** Studies on the Chipola Miocene of Bainbridge, Georgia, and of Alum Bluff, Florida, with an attempt at correlation of certain Grand Gulf Group beds with marine Miocene beds eastward. Am. Jour. Sci. III. **46**:244–254. Oct. 1893.

In the same journal for December 1893 and July 1894 the discussion is continued by the same author and Prof. Raphael Pumpelly, but without special reference to the Altamaha Grit. See Bull. Torrey Club **32**:150 (footnote). 1905.

1896. **Nesbitt, R. T.** Georgia: her resources and possibilities. Pp. xviii + 475. Atlanta (published by the state agricultural department).

A work of similar scope to Henderson's "Commonwealth" (1885), containing fewer maps and more illustrations (most of the latter half-tones), and about the same geographical matter, with the addition of county descriptions.

1898. **McCallie, S. W.** A preliminary report on the artesian-well system of Georgia. Bull. 7, Geol. Surv. Ga. 214 pp. Illustrated.

Contains some valuable notes on the stratigraphy and topography of the coastal plain, but without mentioning the Altamaha Grit by name.

1899. **Gannett, Henry.** A dictionary of altitudes in the United States. Third edition. Bull. 160, U. S. Geol. Surv.

Pages 122–131 refer to Georgia, and include several stations in the Altamaha Grit region.

1899. **U. S. Geological Survey.** (Precise levels from Atlanta to Brunswick). 20th Annual Report, **1**:380–383.

From about Cochran to Jesup this line of levels passes through the Altamaha Grit region, and the figures given show in a striking manner its elevation above contiguous regions.

1900. **Coulter, J. M., & Rose, J. N.** Monograph of the North American Umbelliferæ. Contr. U. S. Nat. Herb. **7**: 1–256. Dec. 31, 1900.

On page 49 are cited two specimens of *Eryngium integrifolium Ludovicianum*, both from the Altamaha Grit region.

1901. **Beadle, C. D., & Boynton, F. E.** Revision of the species of *Marshallia*. Biltmore Bot. Stud, **1**: 3–10. *pl. 1–11*. April 8, 1901.

Contains description of *M. ramosa*, n. sp., based on a single collection from the Altamaha Grit region by C. L. Boynton.

1901. **Small, John K.** The rediscovery of *Elliottia*. Jour. N. Y. Bot. Gard. **2**: 113–114. Aug. 1901. Copied in American Gardening **22**: 631. Sept. 14, 1901.

Refers to the finding of this rare plant in Bulloch County.

1901. **Stevens, O. B., & Wright, R. F.** Georgia, Historical and Industrial. 955 pp., several maps, and numerous illustrations. Atlanta (published by the state agricultural department).

A successor to the works of Janes, Henderson, and Nesbitt (mentioned above), and much more comprehensive.

1902. Sargent, C. S. *Elliottia racemosa.* Silva N. A. **14**:31. *pl. 712.*

1903. Small, John K. Flora of the Southeastern United States. xii + 1370 pp. New York, July 22, 1903.

Reviewed by Beadle in Torreya **3**: 125–127. 1903; Pollard in Plant World, **6**: 192–195. 1903; Clute in Fern Bull. **11**: 27–128. 1903; Coville in Science II. **18**: 626–627. Nov. 13, 1903; and Baker in Jour. Bot. **42**: 56–58. 1904.

Contains descriptions of the following new species based wholly or partly on material from the Altamaha Grit region, collected in Bulloch County in 1901:—*Eriocaulon lineare*, *Siphonychia pauciflora*, *Polygala Harperi*, and *Sabbatia Harperi*. But the type-localities are not designated with sufficient accuracy to show that the plants came from this region.

1904. Warnstorf, C. Neue europaische und exotische Moose. Bot. Centralb. Beihefte **16**: 237–252.

The last species described in this paper is *Sphagnum Harperi*, based on a single collection from the Altamaha Grit region.

1904. U. S. Geological Survey. Report of progress of stream measurements for the calendar year 1903. Part II. Southern Atlantic, eastern Gulf of Mexico, and eastern Mississippi River drainage. Water Supply and Irrigation paper No. 98.

On pages 71–84 are some statistics of the flow of the Canoochee and Ohoopee Rivers in and near the Altamaha Grit region.

1904. Murrill, W. A. The Polyporaceæ of North America. IX. *Inonotus*, *Sesia*, and monotypic genera. Bull. Torrey Club **31**: 593–610. Nov. 1904.

Contains description of *Inonotus amplectens*, n. sp., based on a single collection from the Altamaha Grit region.

1905. U. S. Department of Agriculture. (Annual summaries, Georgia section of climate and crop service of the Weather Bureau, for 1904 and several preceding years.)

Reports from several stations in the Altamaha Grit region are included, and have been used in compiling the climatic data in this work.

1905. Ames, Oakes. Contributions toward a monograph of the American species of *Spiranthes*. Orchidaceæ **1**:113–156. April 8, 1905.

Cites a specimen of *S. Beckii* from the vicinity of Lumber City, presumably collected by C. L. Boynton.

1905. Bush, B. F. The North American species of *Fuirena*. Rep. Mo. Bot. Gard. **16**:87–99.

Cites a specimen of *F. hispida* from Tifton (no. 665).

1905. Fippin, E. O., & Drake, J. A. Soil survey of the Bainbridge area, Georgia. Field operations of the Bureau of Soils, U. S. Dept. Agriculture, for 1904. 25 pp. and map. July, 1905.

The area mapped is all in Decatur County, and about half of it is located

in the Altamaha Grit region near its southwestern end. The remainder of the survey covers portions of the Lower Oligocene, Chattahoochee, and Uppermost Oligocene regions.

1905. **Derry, J. T., & Wright, R. F.** Georgia's resources and advantages. 100 pp. (including numerous full-page illustrations) and several maps. Atlanta (published by the state department of agriculture).

This is practically a much condensed edition of Stevens & Wright's "Georgia, Historical and Industrial," which was published four years earlier.

1905. **Rose, J. N.** Two new Umbelliferous plants from the coastal plain of Georgia. Proc. U. S. Nat. Mus. **29**:441–442. *pl. 3*. Oct. 1905.

The type specimen of one of them, *Zizia arenicola*, is from the Altamaha Grit region.

1905. **Ely, C. W., & Griffen, A. M.** Soil survey of Dodge County, Georgia. Field operations of the Bureau of Soils, U. S. Dept. Agriculture, for 1904. 20 pp. and map. Oct. 1905.

About three-fifths of Dodge County is in the Altamaha Grit region.

There are references to the Altamaha Grit region or its flora at the following places in my own writings, though I did not distinguish it until the summer of 1903, or mention it by name until September, 1904:

Bull. Torrey Club **28**:458–465, 467, 468, 470, 475–477, 479, 480, 483, 484. *pl. 29. f. 3*. Aug. 1901.
Torreya **1**: 115–117. Oct. 1901.
Plant World **5**:87–90. *pl. 13*. 1902.
Bull. Torrey Club **29**: 386, 393, 394, 397. June, 1902.
Plant World **6**: 60. 1903.
Bull. Torrey Club **30**:282–285. *f. 2*. May, 1903; 320, 324, 327, 328, 331, 332, 336–341. June, 1903.
Torreya **3**:106. July, 1903.
Bull. Torrey Club **31**: 13, 15, 17, 19, 22–26. Jan. 1904.
Torreya **4**:139–141. (*Illust.*) Sept. 1904.
Torreya **4**:162. Nov. 1904.
Bull. Torrey Club **32**:108, 109, 111. *f. 2–4*. 1905.
Fern Bull. **13**:3, 13–16. 1905.
Rhodora **7**:76–77 (one sentence). April, 1905.
Bull. Torrey Club **32**:141–147, 150–153, 159, 160, 162, 165–170. *f. 1, 3*. 1905.
Bull. Torrey Club **32**:452, 460–467. *f. 4, 5*. Sept. 1905.
Torreya **5**:164. Sept. 1905.
Torreya **5**:183–185. Oct. 1905.

Also in the following reports of meetings of the Torrey Botanical Club:

Bull. Torrey Club **28**: 648. Nov. 1901; Science II. **14**:850. Nov. 29, 1901.

Torreya 3:77–78. May, 1903. (See Just's Bot. Jahresb. 31[1]. 508. 1904.)
Science II. **21**:920–921. June 16, 1905; Torreya **5**:113–115. June, 1905.

2. Other works consulted. To enumerate all from which suggestions have been derived would involve several hundred titles, but the following seem to be the most important, and in some of them may be found references to other works of like nature, together covering almost the whole field of phytogeography. A few titles mentioned in footnotes on the preceding pages, or in my own earlier papers, are not repeated here.

The names of authors are arranged alphabetically, and the works of each (where more than one) chronologically.

Adams, Chas. C. Southeastern United States as a center of geographical distribution of flora and fauna. Biol. Bull. **3**:115–131. July, 1902.
Reviewed by Cowles in Bot. Gaz. **34**:385. Nov. 1902.

Adams, Chas. C. Postglacial origin and migrations of the life of the northeastern United States. Jour. Geog. **1**:303–310, 352–357. *Map.* 1902.

Adams, Chas. C. The postglacial dispersal of the North American biota. Biol. Bull. **9**:53–71. *f. 1.* June, 1905; Rep. 8th Int. Geog. Cong. 623–637. *Map.* 1905.

Atkinson, G. F. Relation of plants to environment (or plant ecology) (Outlines of a course of lectures). 67 pp. Ithaca, 1904.
Contains an excellent bibliography.

Bartram, William. Travels through North and South Carolina, Georgia, East and West Florida (etc.). xxiv + 526 pp., frontispiece, map, and 7 plates. Philadelphia, 1791, London, 1792 (these two not seen), Dublin, 1793, London, 1794. Also a German translation, published in Berlin in 1793.

A most interesting narrative, describing faithfully the flora and other geographical features of these regions as they appeared in the 18th century. The author in all probability crossed the extreme northeastern end of the Altamaha Grit region more than once, but there is no direct evidence of it in the book.

Beal, W. J. Some unique examples of dispersion of seeds and fruits. Am. Nat. **32**:859–866. 1898.

Beal, W. J. Michigan Flora. Ann. Rep. Mich. Acad. Sci. **5**:1–147. 1905.
The first 34 pages contain some very interesting phytogeographical as well as historical information.

Beck von Mannagetta, G. Ueber die Umgrenzung der Pflanzenformationen. Oesterr. Bot. Zeit. **52**:421–427. 1902.
Reviewed by Cowles in Bot. Gaz. **36**:396. Nov. 1903.

Blankinship, J. W. Plant formations of eastern Massachusetts. Rhodora 5:124–137. May, 1903.

This is the first work of its kind for New England, and contains several original ideas well worth imitating.

Bray, W. L. The ecological relations of the vegetation of western Texas. Bot. Gaz. **32**:99–123, 195–217, 262–291. *f. 1–24*. 1901.

The author had the advantage of working in a sparsely settled region whose geology and climatology were already pretty well known, and he made good use of his opportunities. Two papers dealing with the forests of the same general region by the same author, published as bulletins of the U. S. Bureau of Forestry in 1904, are also of considerable interest.

Brendel, F. Notes on the flora of southern Florida. Am. Nat. **8**:449–452. Aug. 1874.

One of the earliest discussions of the geographical affinities of this flora.

Britton, W. E. Vegetation of the North Haven sand plains. [New Haven County, Connecticut.] Bull. Torrey Club **30**: 571–620. *pl. 23–28*. Nov. 1903. (Thesis).

The area discussed is comparable in many respects with the sand-hills of the Altamaha Grit region, and resembles most of them in being on the left side of the stream. Unfortunately no distinction is made by the author between native and introduced plants.

Catesby, Mark. The Natural History of Carolina, Florida, and the Bahama Islands. 2 vols. London, 1754. (There was also an earlier edition.)

The latter part of the second volume contains some interesting geographical matter.

Clarke, Henry L. The philosophy of flower seasons. Am. Nat. **27**:769-781. Sept., 1893.

Clements, F. E. A system of nomenclature for phytogeography. Engler's Bot. Jahrb. Beibl. **70**:1–20. Aug. 29, 1902.

Advocates giving technical names to all classes of habitats, and presents an elaborate system of this kind.

Clements, F. E. The development and structure of vegetation. Bot. Surv. Nebr. **7**:5–175. April, 1904.

An excellent synopsis of the subject, with a good bibliography, but no index or table of contents. Reviewed by Ganong in Science, II. **20**: 177. Aug. 5, 1904; and by Cowles in Bot. Gaz. **38**: 303–304. Oct. 1904.

Clements, F. E. Research methods in ecology. xvii + 334 pp., 85 figs. Lincoln, Neb. 1905.

Covers most of the same ground as the preceding, with considerable additional matter and a greatly improved typography, but no index. Reviewed by MacMillan in Science II. **22**: 45–46. July 14, 1905.

Clements, F. E. See also **Pound & Clements.**

Coulter, J. M. Plant Relations. 264 pp., 206 figs. New York, 1899.
One of the best of the modern text-books.

Coulter, S. M. An ecological comparison of some typical swamp areas. Rep. Mo. Bot. Gard. **15**:39–71, *pl. 1–24.* 1904. (Thesis.)
Contains a good deal of information and some excellent illustrations, but few generalizations or deductions. Reviewed by J. M. Coulter in Bot. Gaz. **38**:156–157. Aug. 1904.

Coville, F. V. Botany of the Death Valley Expedition. Contr. U. S. Nat. Herb. vol. 4. 363 pp., 22 plates and map. Nov. 29, 1893.
Pages 10–55 and 284–300 are the most valuable to the reader who has no special interest in the region or its flora.

Cowles, H. C. The ecological relations of the vegetation on the sand dunes of Lake Michigan. Bot. Gaz. **27**:95–117; 167–202, 281–308, 361–391. *f. 1–26.* 1899. (Thesis.) (Contr. Hull Bot. Lab. No. 13.)
One of the foremost works of its kind, cited in most subsequent American phytogeographical papers.

Cowles, H. C. The physiographic ecology of Chicago and vicinity; a study of the origin, development, and classification of plant societies. Bot. Gaz. **31**:73–108, 145–182. *f. 1–35.* 1901. (Contr. Hull Bot. Lab. No. 24.)
This is of rather broader application than the preceding, and will probably for a long time remain a standard. To praise it would be superfluous.

Cowles, H. C. The influence of underlying rocks on the character of the vegetation. Bull Am. Bureau Geog. **2**:163–176, 376–388. *f. 1–10.* 1901. (Contr. Hull Bot. Lab. No. 34.)
Argues that topographic history is more potent than geological age or chemical composition of the strata in determining the character of the vegetation.

Cowles, H. C. Recent contributions to American phytogeography: the Eastern United States. Bot. Gaz. **34**: 383–387. Nov. 1902.

Cowles, H. C. Recent contributions to American phytogeography. Bot. Gaz. **35**:147–149. Feb. 1903.

Croom, H. B. Botanical communications. Am. Jour. Sci. **25**: 69–78. Oct. 1833; **26**:313–320. July, 1834; **28**:165–168. April, 1835.
These papers contain some very interesting notes on plants observed near if not in the Altamaha Grit region.

Davis, W. M. Systematic geography. Proc. Am. Phil. Soc. **41**:235–259. 1902.

Davis, W. M. A scheme of geography. Jour. Geog. **3**:20–31. Jan. 1904

Davis, W. M. Geography in the United States. (Vice-presidential address.) Science II. **19**:121–132,178–186. Jan. 1904; Am. Geol. **33**: 156–185. March, 1904.

DeCandolle, A. Géographie botanique raisonnée, ou exposition des faits principaux et des lois concernant la distribution géographique des plantes de l'époque actuelle. 2 vols. Paris, 1855.
Reviewed by W. J. Hooker in Hook. Jour. Bot. **8**:54–64, 82–88, 112–121, 151–157, 181–191, 214–219, 248–256. 1856; also by Gray in Am. Jour. Sci. II. **22**:429–432. 1856.

Drayton, John. A view of South Carolina, as respects her natural and civil concerns. 252 pp. (Illus.) Charleston, 1802.
Contains some very interesting notes on the geographical features, particularly of the coastal plain. Much of the description would have applied equally well to the corresponding parts of Georgia

Drude, Oscar. Handbuch der Pflanzengeographie. 582 pp. Stuttgart, 1890.

Drude, Oscar. Deutschlands Pflanzengeographie. 502 pp. Stuttgart, 1896.
Reviewed by Pound in Am. Nat. **30**:465–468. 1896.

Engler, A. Die pflanzengeographische Gliederung Nordamerikas. Notizbl. Kgl. Bot. Gart. & Mus. Berlin, App. 9:1–94, and maps. May 15, 1902.
A pretty accurate piece of work for one based entirely on scattered phytogeographical literature written by many different persons from as many different points of view. Reviewed by Cowles in Bot. Gaz. **34**:316–317. Oct. 1902.

Engler, A., & Drude, O. (editors). Die Vegetation der Erde.
Six volumes have thus far appeared, and reviews of each by Dr. Cowles may be found in recent volumes of the Botanical Gazette.

Fendler, A. On prairies. Am. Jour. Sci. II. **41**:154–158. March, 1866.
Considers fire the leading factor in the replacement of forests by grass land. Some of his observations may have some bearing on the pine-barren question.

Flahault, C. A project for phytogeographic nomenclature. (Translated from French.) Bull. Torrey Club **28**:391–409. July, 1901.
Contains an extensive bibliography, among other things. Reviewed by Cowles in Bot. Gaz. **32**:376. Nov. 1901.

Ganong, W. F. The cardinal principles of ecology. Science II. **19**: 493–498. March 25, 1904.

(Gaskill, Alfred). Why prairies are treeless. (Abstract.) Science II. **22**:55–56. July 14, 1905.

Gattinger, A. The flora of Tennessee (ed. 2) and a philosophy of botany. 296 pp. Nashville, 1901. (Published by the state.)

The correlations of vegetation with geology, in the introductory pages, are excellent, except for the coastal plain (West Tennessee), which the author had not often visited.

Gray, Asa. Analogy between the flora of Japan and that of the United States. Am. Jour. Sci. II. **2**:135–136. 1846.

Gray, Asa. Statistics of the flora of the Northern United States. Am. Jour. Sci. II. **22**:204–232. 1856; **23**:62–84, 369–403. 1857.

A very interesting paper. The author recognizes five natural divisions of the region (pp. 394–395), and discusses their flora, but does not define them in terms of any environmental factors.

Gray, Asa. Diagnostic characters of new species of phænogamous plants, collected in Japan by Charles Wright. . . . With observations upon the relations of the Japanese flora to that of North America, and of other parts of the North Temperate zone. Mem. Am. Acad. **6**: 377–449. 1859.

Gray, Asa. Forest geography and archæology. Am. Jour. Sci. III. **16**: 85–94, 183–196. 1878.

Gray, Asa. The pertinacity and predominance of weeds. Am. Jour. Sci. III. **18**: 161–167. 1879.

Gray, Asa. Characteristics of the North American flora. Am. Jour. Sci. III. **28**: 323–340. 1884

This may perhaps be considered the best of Dr. Gray's papers, from a phytogeographical standpoint. It has never since been surpassed by anything of similar scope.

Grisebach, A. H. R. Die Vegetation der Erde. 2 vols Leipsic, 1872.

Haddon, Alfred C. The saving of vanishing data. Pop. Sci. Monthly **62**: 222–229. Jan. 1903.

Addressed primarily to zoologists and anthropologists, but the general principles involved are equally important to phytogeographers.

Harshberger, J. W. An ecologic study of the flora of mountainous North Carolina. Bot. Gaz. **36**: 241–258, 368–383. Oct. 1903.

An excellent discussion of the relation between physiographic history and phytogeography in a region whose flora is the most ancient of any in Eastern North America.

Harshberger, J. W. A phyto-geographic sketch of extreme southeastern Pennsylvania. Bull. Torrey Club **31**: 125–159. *f. 1–4*. March, 1904.

Of somewhat similar scope to the preceding paper, and more free from some of its mechanical defects, such as lack of italics and illustrations.

Harshberger, J. W. The comparative age of the different floristic elements of Eastern North America. Proc. Acad. Nat. Sci. Phila. **56**: 601–615. Oct. 1904.

Largely a compilation of the phytogeographical work of several writers, from which some interesting but not always obvious conclusions are drawn.

Harshberger, J. W. Methods of determining the age of the different floristic elements of Eastern North America. Rep. 8th Int Geog. Cong. 601–607. 1905.

Essentially an abridgment of the preceding paper.

Hildebrand, F. Die Verbreitungsmittel der Pflanzen. 162 pp. 8 figs. Leipsic, 1873.

Hilgard, E. W. Report on the Geology and Agriculture of the State of Mississippi. xxiv+391 pp. & map. Jackson, 1860 (published by the state).

Contains an excellent discussion of the details of geology, soil, topography, vegetation, and the relations between them, for nearly all parts of the state. But for the fact that plants are mentioned in this work only incidentally, and no complete enumeration of them is attempted, this would be one of the most satisfactory local floras ever published.

Hilgard, E. W. Soil studies and soil maps. Overland Monthly (3–12), Dec. 1891.

Hill, E. J. Means of plant dispersion. Am. Nat. **17**: 811–820, 1028–1034. 1883.

Contains much of interest to phytogeographers.

Hitchcock, A. S. Ecological plant geography of Kansas. Trans. Acad. Sci. St. Louis **8**:55–69. *Map*. March 8, 1898.

This seems to be the first of the now rather numerous American works containing the word "ecological" in its title.

Hitchcock, A. S. A brief outline of ecology. (Presidential address.) Trans. Kans. Acad. Sci. **17**: 28–34. 1901.

Hollick, Arthur. The relation between forestry and geology in New Jersey. (Report on forests, in) Ann. Rep. State Geol. N. J. for 1899, 177–201. 1900. Also essentially the same in Am. Nat. **33**: 1–14, 109–116. 1899.

A very interesting discussion of the causes affecting distribution of trees.

Jackson, Joseph. Through Glade and Mead: a contribution to local natural history. (With a flora of Worcester County, Massachusetts.) xiv + 332 pp. and several full-page illustrations (9 half-tones in the regular edition and about a dozen platinum prints in the special). Worcester, 1894.

Although this deals with a region very different from that here discussed, and from a very different standpoint, I have derived much

inspiration from it, especially when living in the region covered by the work. It deserves to be much more widely known than it is.

Kearney, T. H. The plant covering of Ocracoke Island; a study in the ecology of the North Carolina strand vegetation. Contr. U. S. Nat. Herb. **5:** 261–319. *f. 33–50.* Aug. 1, 1900.

An excellent paper, probably the first of its kind for the coastal plain. Reviewed by Cowles in Bot. Gaz. **34:** 384. Nov. 1902.

Kearney, T. H. The Lower Austral element in the flora of the southern Appalachian region. A preliminary note. Science II. **12:** 830–842. Nov. 30, 1900.

This is one of the earliest discussions of the phytogeographical problems of the southeastern states. Reviewed by Cowles in Bot. Gaz. **31:** 208. March, 1901. See also Rhodora **7:** 78, 79; Torreya **5:** 58. April, 1905.

Kearney, T. H. Report on a botanical survey of the Dismal Swamp region. Contr. U. S. Nat. Herb. **6:** i-x, 321–550. *pl. 65–73, f. 51–84,* and 2 maps. Nov. 6, 1901.

This easily ranks among the foremost of American phytogeographical works. Reviewed by Cowles in Bot. Gaz **34:** 384-385. Nov. 1902. See also Bull. Torrey Club **29:** 387. June, 1902; Torreya **3:** 121. Aug. 1903.

Kerner von Marilaun, A. Pflanzenleben. 2 vols., 734 & 896 pp., and about 200c illustrations. Leipsic and Vienna, 1890–1891.

English translation by F. W. Oliver and others. 2 vols. in 2 parts each.

Second edition, 2 vols., 766 & 778 pp. 1896–1898. (Not seen.)

Reviewed by Cowles in Bot. Gaz. **26:** 361–362. 1898.

This perhaps comes nearer to covering the whole field of botany than any other one work, and is full of valuable suggestions.

Knowlton, F. H. The misuse of "formation" by ecologists. Science II. **19:** 467–468. March 18, 1904.

Kraemer, Henry. Plant morphology and taxonomy. Am. Jour. Pharm. **77:** 401–416. Sept. 1905.

Livingston, B. E. Physiological properties of bog water. Bot. Gaz. **39:** 348–355. May, 1905.

Discusses a problem of which the Altamaha Grit region furnishes innumerable examples. Also refers to several of his earlier papers which are worth consulting.

Lloyd, F. E., & Tracy, S. M. The insular flora of Mississippi and Louisiana. Bull. Torrey Club **28:** 61–101. *pl. 8–11.* March, 1901.

MacDougal, D. T. Some aspects of desert vegetation. Plant World **6:** 249–257. *pl. 32–36. f. 1–5.* Nov. 1903. (Contr. N. Y. Bot. Gard. No. 46.)

Interesting to compare with the sand-hill vegetation herein described.

MacMillan, Conway. The Metaspermæ of the Minnesota valley. xiii + 826 pp. Minneapolis, Dec. 29, 1892. (Published by the state.)

A remarkable work for its time, containing besides a great mass of synonyms and statistics some very interesting suggestions in regard to geographical distribution. Reviewed by Jos. F. James in Science **21**: 221–223. April 21, 1893.

MacMillan, Conway. Minnesota Plant Life. 568 pp., 4 plates, 240 figures. St. Paul, 1899. (Published by the state.)

A finely illustrated work, with a good deal of interesting information in the first 25 and last 100 pages. Reviewed by Cowles in Bot. Gaz. **29**: 283–285. 1900.

McCarthy, Gerald. The study of local floras. Jour. Elisha Mitchell, Sci. Soc. **4^2**: 25–29. 1887.

McGee, W J The Lafayette formation. Ann. Rep. U. S. Geol. Surv. **12^1**: 347–521. *pl. 32–41. f. 28–72.* 1892.

This monograph, which no coastal plain botanist can afford to overlook, combines the substance of several earlier papers on the same subject, with the addition of considerable new matter and illustrations. Reviewed by Upham in Am. Geol. **14**: 115–116. 1894.

Merriam, C. Hart. Laws of temperature control of the geographic distribution of terrestrial animals and plants. Nat. Geog. Mag. **6**: 229–238. *pl. 12–14.* 1894.

Several other papers by Dr. Merriam are often cited in modern phytogeographical works, but this one seems to contain the essence of all of them. The fact that one of his "life-zones" coincides approximately with the coastal plain has obscured the true significance of the latter in the minds of many botanists ever since. See Bull. Torrey Club **31**: 10. 1904.

Mohr, Charles. Plant Life of Alabama. Contr. U. S. Nat. Herb. vol. 6. 921 pp., 1 map, and 12 other plates, made from drawings of individual plants. July 31, 1901. Also published by the Geological Survey of Alabama, with the addition of a biography and portrait of the author.

By far the most important phytogeographical work, and at the same time the best state flora, hitherto published for the southeastern states. Reviewed by Clements in Science II., **15**: 23–24. Jan. 3, 1902.

Nash, Geo. V. Notes on some Florida plants. Bull. Torrey Club **22**: 141–161. 1895.

Some interesting phytogeographical notes on the first six pages.

Olsson-Seffer, Pehr. The principles of phytogeographic nomenclature. Bot. Gaz. **39**: 179–993. March, 1905.

Pinchot, Gifford. A primer of forestry. Part I.—The forest. Bull. U. S. Dept. Agr. Div. Forestry, **24^1**: 1–88. *pl. 0, 1–47. f. 83.* 1899.

Pound, Roscoe, & Clements, Frederic E. Phytogeography of Nebraska. Ed. 2. 442 pp. Lincoln, 1900.
This work and its predecessor are too well known to require any comment here. The fact that the names of plants are not italicized, a mere mechanical detail, is perhaps its most obvious defect. Reviewed by Colton Russell in Am. Nat. **35:** 600–602. 1901.

Reed, Howard S. A brief history of ecological work in botany. Plant World **8:** 163–170, 198–208. 1905

Robertson, Charles. The philosophy of flower seasons, and the phænological relations of the entomophilous flora and the anthophilous insect fauna. Am. Nat. **29**:97–117. *pl. 8–10.* Feb. 1895.

Robinson, B. L. Problems and possibilities of systematic botany. (Presidential address.) Science II. **14:** 465–474. Sept. 27, 1901. (Reprinted as publication no. 18, Bot. Soc. Am.)

Rowlee, W. W. The swamps of Oswego County, N. Y., and their flora. Am. Nat. **31:** 690–699, 792–800. 1897.

Schimper, A. F. W. Pflanzengeographie auf physiologische Grundlage. 877 pp. Jena, 1898.
Reviewed by Cowles in Bot. Gaz. **27:** 214–216. 1899.
English translation and revision by Fisher, Groom & Balfour. 1903. Reviewed by Pollard in Plant World **7:** 52. Feb. 1904; and Cowles in Bot. Gaz. **37:** 392–393. May, 1904.

Shaler, N. S. Notes on the *Taxodium distichum*, or bald cypress. Mem. Mus. Comp. Zool. Harvard Coll. **16**[1]: 1–15. 1887.

Shaler, N. S. General account of the fresh-water morasses of the United States. Ann. Rep. U. S. Geol. Surv. **10:** 255–339. *pl. 6–19. f. 2–38.* 1890.
Contains much of botanical interest. See Bull. Torrey Club **29:** 387. 1902.

Shaler, N. S. The origin and nature of soils. Ann. Rep. U. S. Geol. Surv. **12**[1]: 213–345. *pl. 2–31. f. 1–27.* 1892.
Reviewed by Upham in Am. Geol. **14:** 114–115. 1894. This paper should form a foundation for all detailed phytogeographic work, especially that relating to succession of vegetation.

Shaler, N. S. Aspects of the earth; a popular account of some familiar geological phenomena. 344 pp. and numerous illustrations. New York, 1896.

Shimek, B. The flora of the Sioux Quartzite in Iowa. Proc. Ia. Acad. Sc. **4:** 72–77. 1897; **5:** 28–31. 1898.
Discusses some interesting phases of distribution, which find an analogy in the rock outcrops of the Altamaha Grit region.

Smith, Eugene A., and others. Report on the geology of the coastal plain of Alabama. xxiv + 759 pp. Illustrated. Montgomery, 1894 (published by the state).

One of the most important contributions to the knowledge of coastal plain geology ever published. Contains many interesting notes on the trees and other vegetation characterizing different formations.

Spalding, V. M. "The Plains" of Michigan. Am. Nat. **17**: 249–259. 1883.

Describes a region similar in some of its phytogeographical and economic aspects to the pine-barrens of the coastal plain.

Spalding, V. M. The distribution of plants. Am. Nat. **24**: 819–831. Sept. 1890.

Spalding, V. M. The rise and progress of ecology. (Presidential address.) Science II. **17**: 201–210. Feb. 6, 1903.

Warming, E. On the vegetation of tropical America. Bot. Gaz. **27**: 1–18. Jan. 1899.

Warming, E. Lehrbuch der oekologischen Pflanzengeographie. Second German edition, translated from the Danish by E. Knoblauch and revised by P. Graebner. 442 pp. Berlin, 1902.

The first edition was reviewed by Coulter in Bot. Gaz. **22**: 173–175. 1896.

White, C. A. The relation of phylogenesis to historical geology. Science II. **22**: 105–113. July 28, 1905.

Woodworth, J. B. The relation between baseleveling and organic evolution. Am. Geol. **14**: 209–235. Oct. 1894.

(**Zon, Raphael.**) Principles involved in determining forest types. (Abstract.) Science II. **22**: 56–57. July 14, 1905.

PLATE I.

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PLATE I.

PAGE

FIG. 1.—Flat outcrop of Altamaha Grit on right bank of Ohoopee River, Tattnall Co. June 24, 1903. Dry and intermediate pine-barrens in background 41

FIG. 2.—Cliffs of Altamaha Grit in pine-barrens near Pendleton Creek, Tattnall Co. April 25, 1904. *Pinus palustris* and a few small specimens of *Liquidambar* appear in the view . . 41

FIG. 1.

FIG. 2.

PLATE II.

PLATE II.

PAGE

FIG. 1.—Dry pine-barrens near Douglas; typical winter aspect. Feb. 7, 1904. Numerous small oaks can be seen, most if not all of them probably *Q. brevifolia*. A "dreen" or incipient branch-swamp, characterized by *Pinus Elliottii* (both large and small specimens), begins near the center of the view and flows toward the left 44

FIG 2.—Dry pine-barrens about three miles south of Moultrie, Colquitt Co. Aug. 25, 1903. Trees nearly all *Pinus palustris* A good deal of *Pteridium* in the foreground . . . 44

FIG. 1.

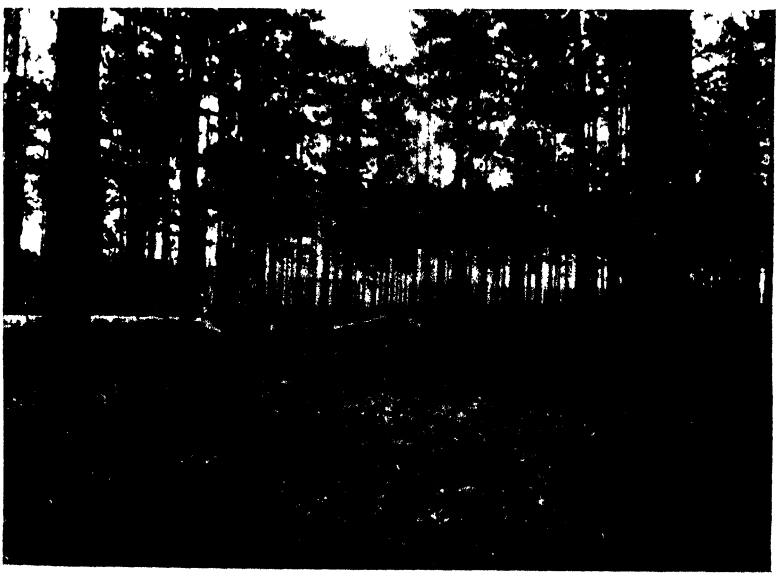

FIG. 2.

PLATE III.

PLATE III.

PAGE

FIG 1.—Intermediate pine-barrens south of Moultrie, Colquitt Co. Sept. 20, 1902. (The pines here are all turpentined, as is now the case nearly everywhere in this region) . . . 50

FIG. 2 —Moist pine-barrens about two miles northeast of Moultrie. Sept. 22, 1902. Shows *Pinus Elliottii*, *Sarracenia flava*, *Eriocaulon decangulare*, *Laciniaria spicata*, *Mesadenia lanceolata virescens*, etc. 54

FIG 1

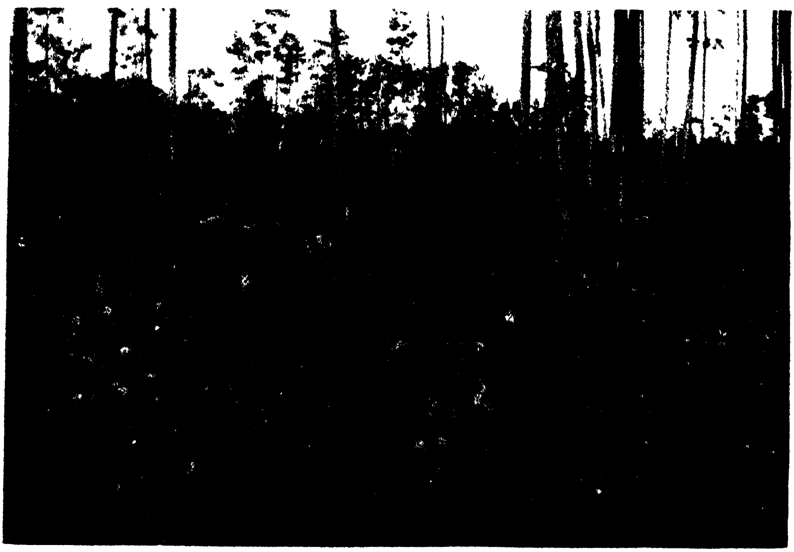

FIG. 2.

PLATE IV.

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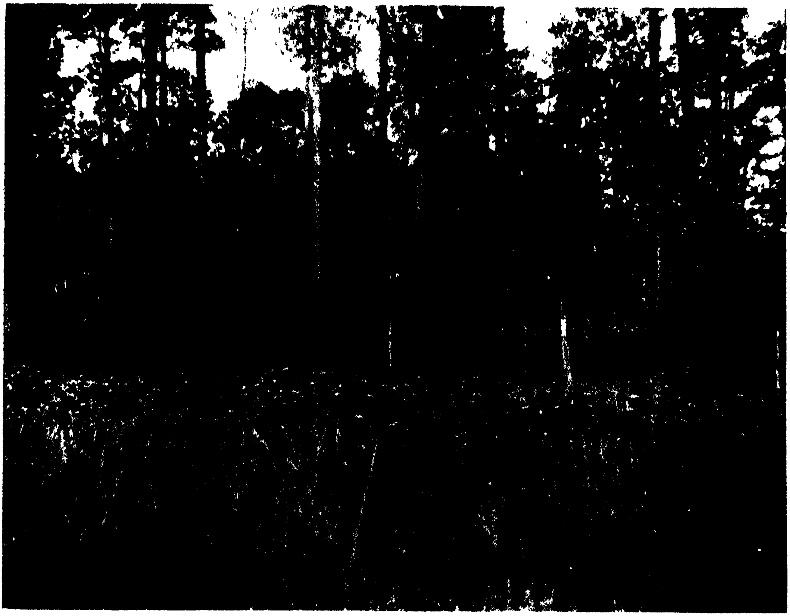

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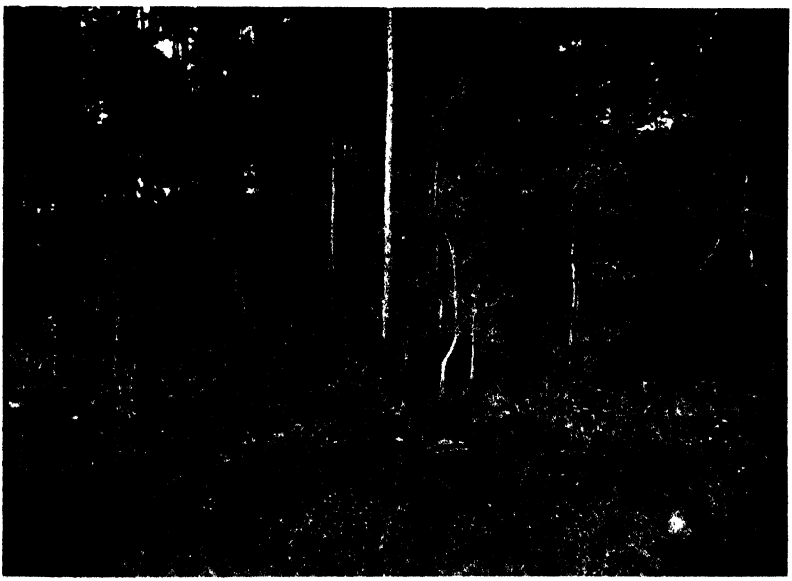

FIG. 2.

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Small branch-swamp in pine-barrens near Douglas, Coffee Co. Feb. 7, 1904. Contains *Pinus Elliottii*, *Taxodium imbricarium*, and very few shrubs. Dry pine-barrens with *Pinus palustris* in foreground 63, 305, 308

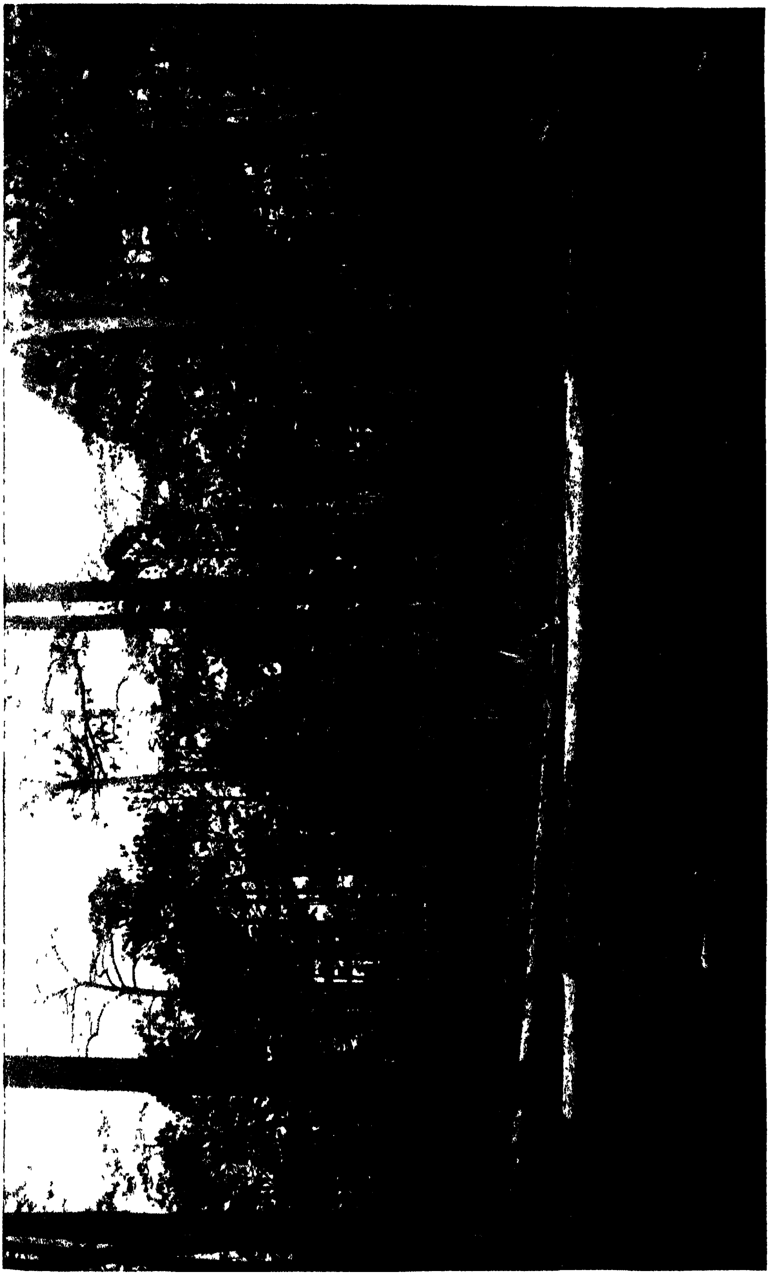

PLATE VI.

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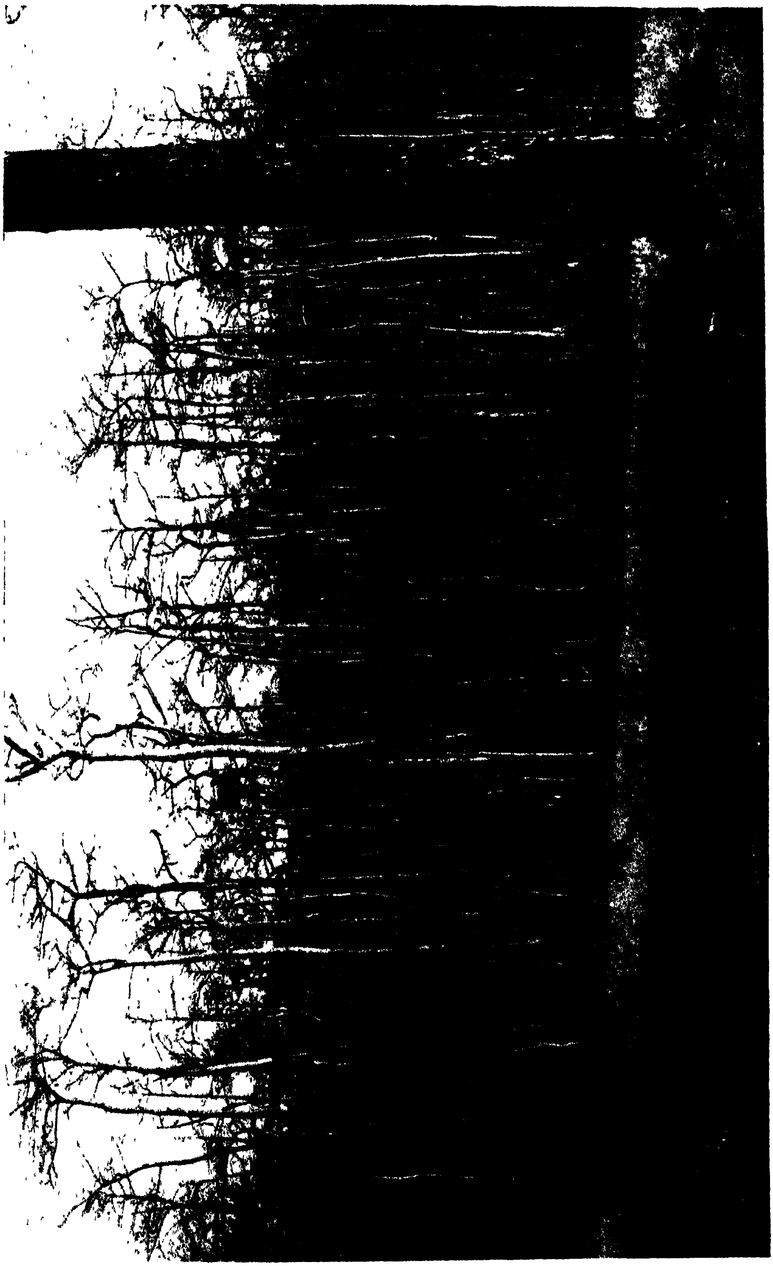
Winter aspect of an "endemic" creek-swamp. Twenty Mile Creek, Coffee County. Feb. 5, 1904. Trees all deciduous, and nearly all *Taxodium imbricarium*. *Dendropogon usneoides* is on some of them. A fringe of shrubs, mostly *Cyrilla* and *Fraxinus Caroliniana*, along the edge. Dry pine-barrens with a specimen of *Pinus palustris* in the foreground 66, 308



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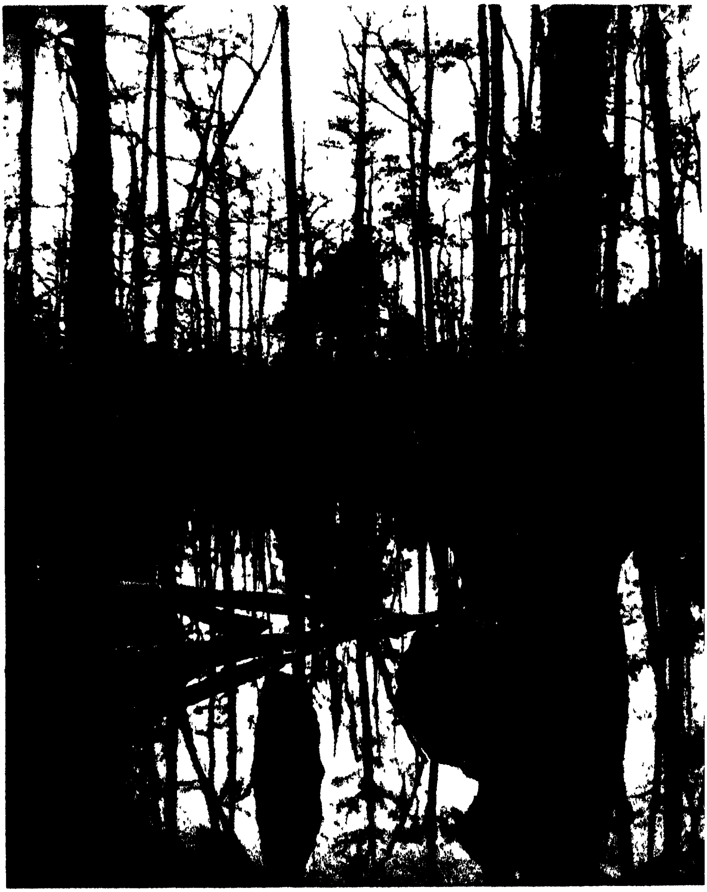

PLATE VIII

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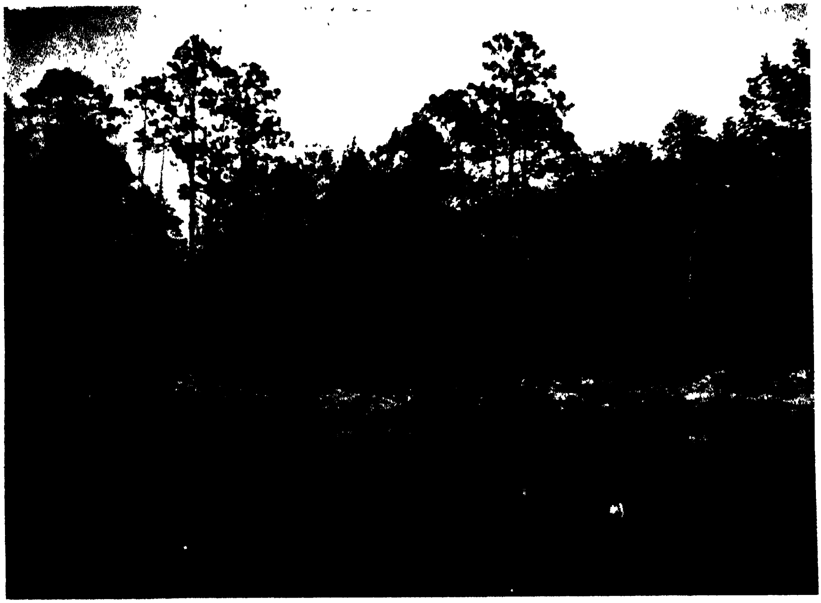
FIG. 1.—Looking across the Ohoopee River from the right bank at same point shown on Plate VIII, fig 2. April 26, 1904. *Salix nigra* on sandy bank opposite, and *Pinus palustris* on sand-hills beyond 69

FIG. 2.—One of the muddy rivers: the Ocmulgee. Looking down-stream from the railroad bridge near Lumber City. Sept. 11, 1903. *Taxodium distichum* on both banks. 71, 307



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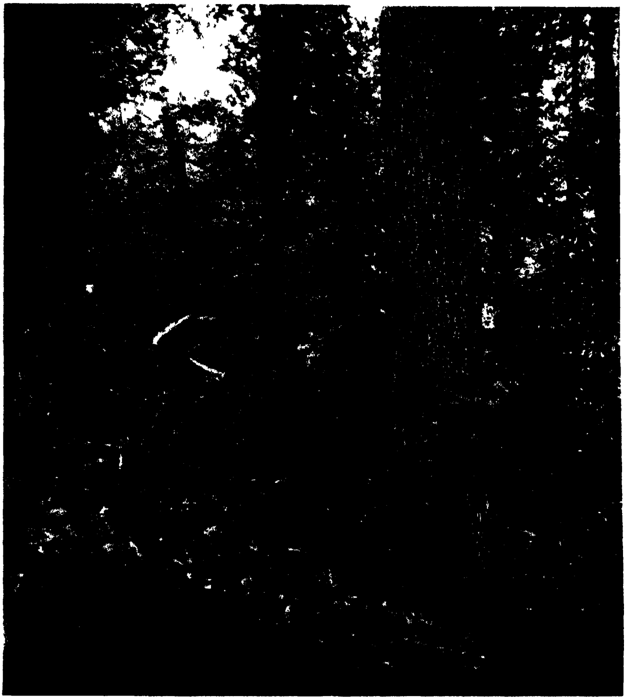

FIG. 1

FIG. 2.

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Non-alluvial swamp of Seventeen Mile Creek near Gaskin's Spring, Coffee Co. May 12, 1904. The large tree is *Magnolia glauca*, 85 inches in circumference. Next to it on the left is a trunk of *Gordonia*, and next to that, *Persea*. *Osmanthus*, *Itea*, and *Vitus rotundifolia* are also visible 93

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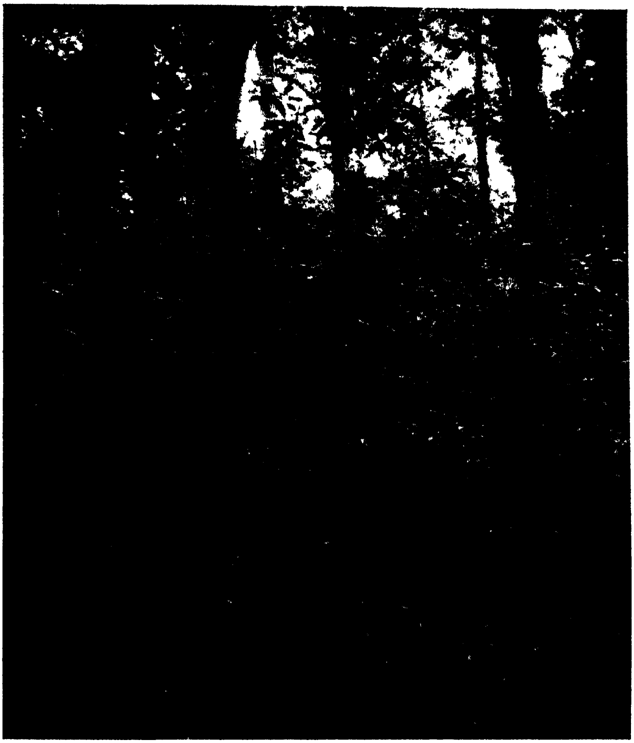

FIG. 1

FIG. 2.

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FIGS. 1 and 2.—Sand-hammock on Fifteen Mile Creek near Rosemary Church, Emanuel Co. June 28, 1901. *Rhynchospora dodecandra* and *Paronychia herniarioides* in upper picture, *Pinus palustris* and *Quercus Catesbæi* in both . . . 97

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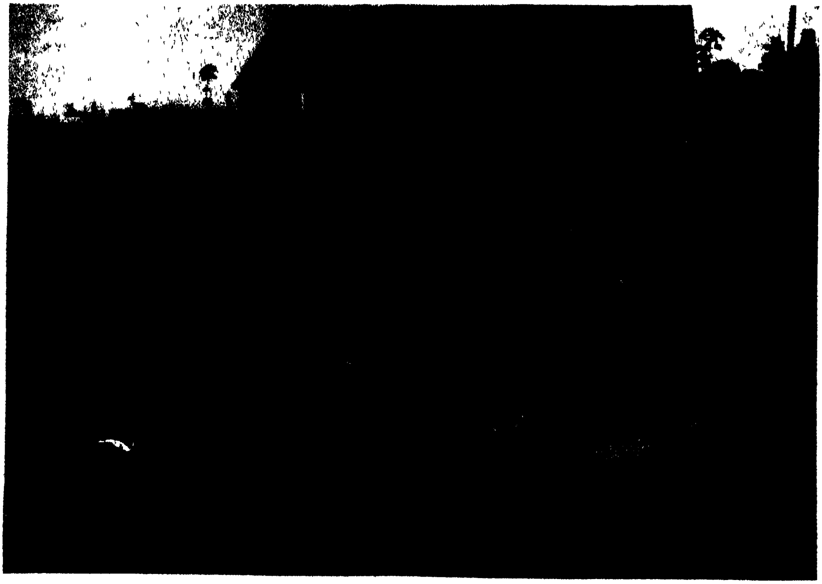

FIG. 1.

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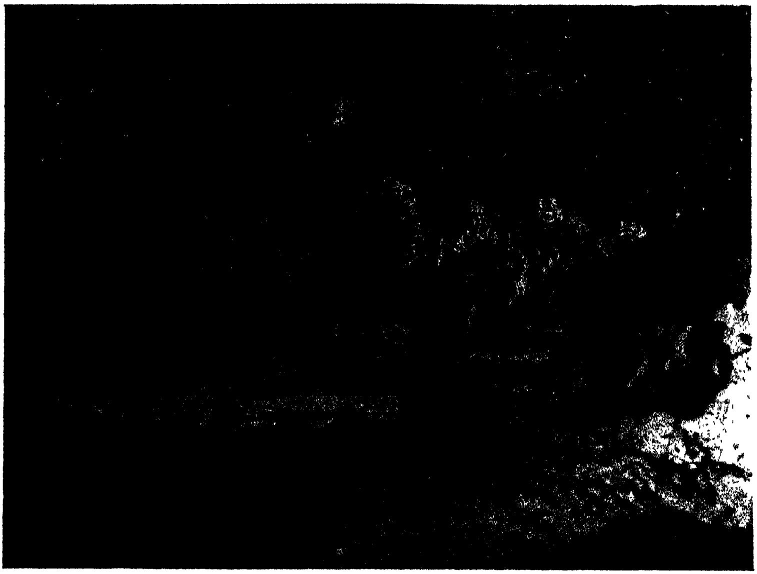

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PLATE XXI.

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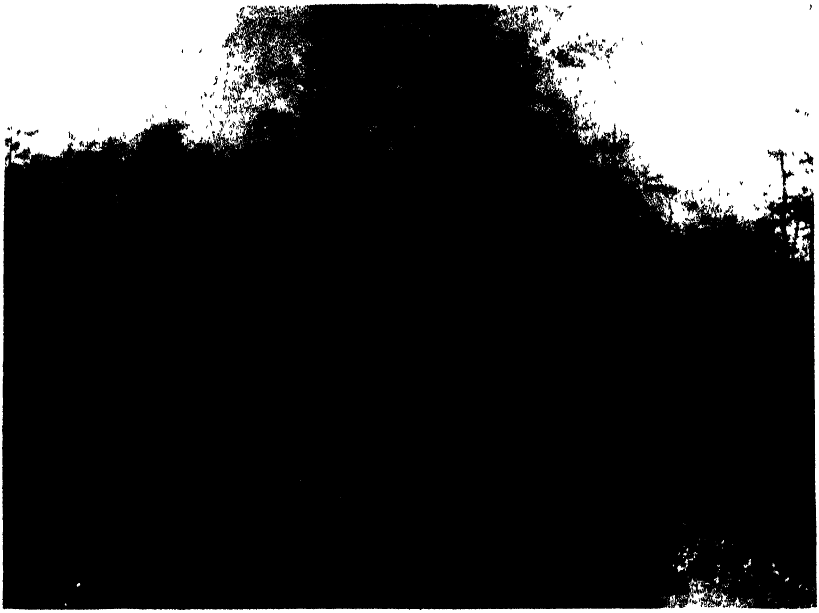

FIG. 1.

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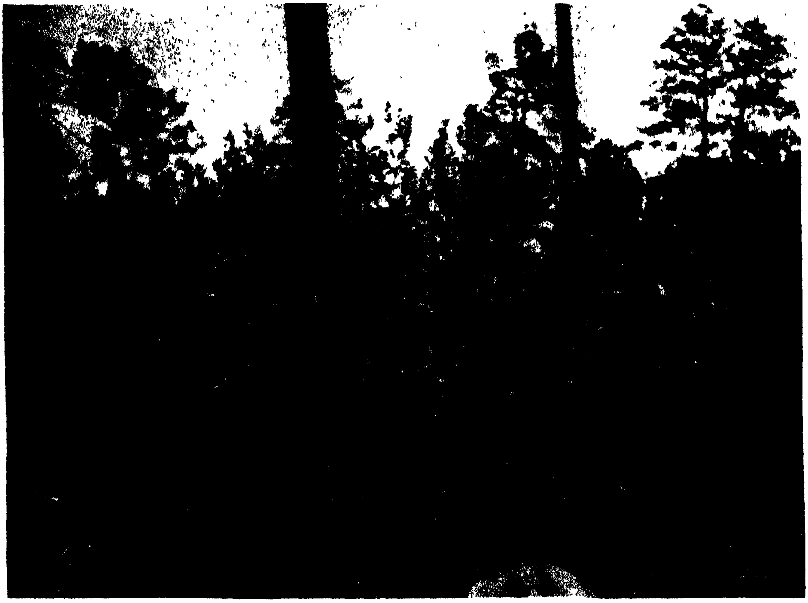

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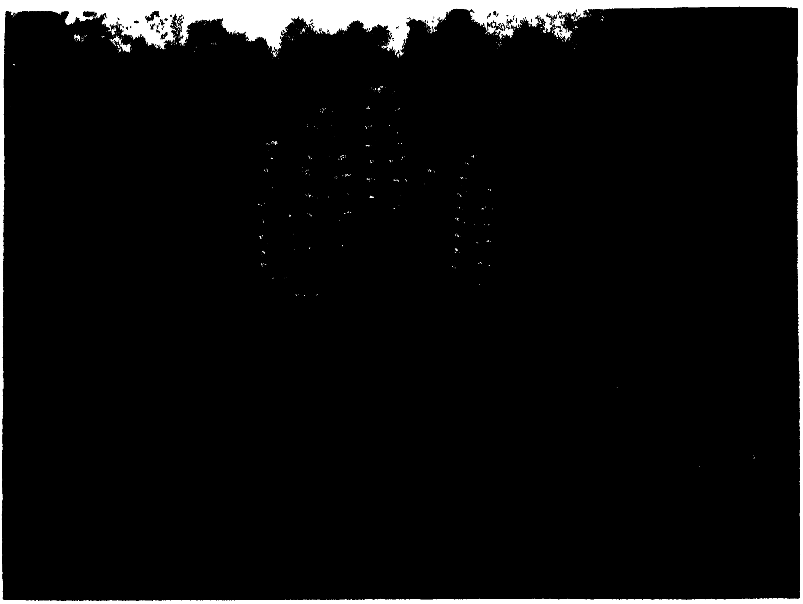

FIG. 2.

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Sarracenia flava in moist pine-barrens (already deforested) in Douglas, Coffee Co. May 15, 1904. *Eriocaulon lineare* conspicuous in foreground 233

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FIG. 2.

FIG. 1.

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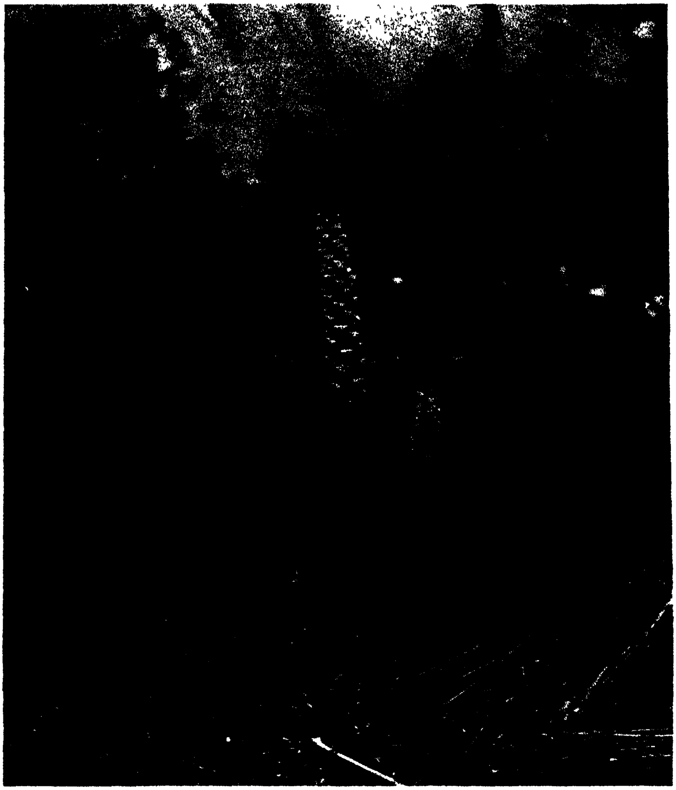

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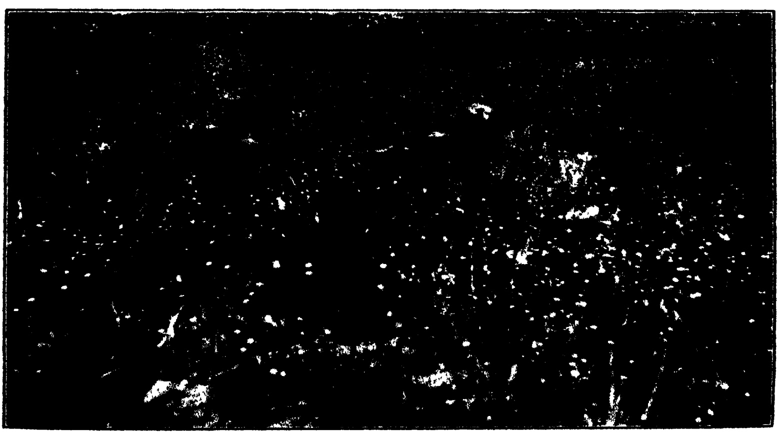

FIG. 2.

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Pinus palustris in dry pine-barrens near Douglas, Feb. 7, 1904. The specimen in the foreground is just three feet in diameter at the place indicated by the tape 304

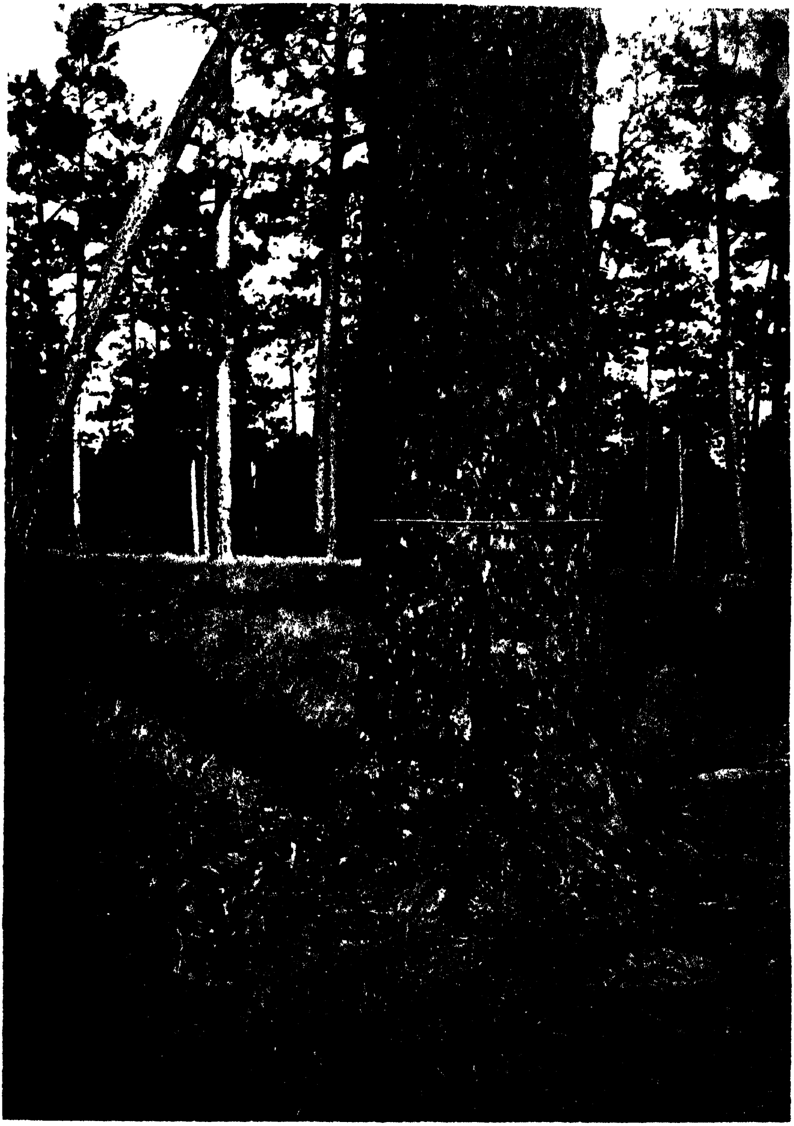

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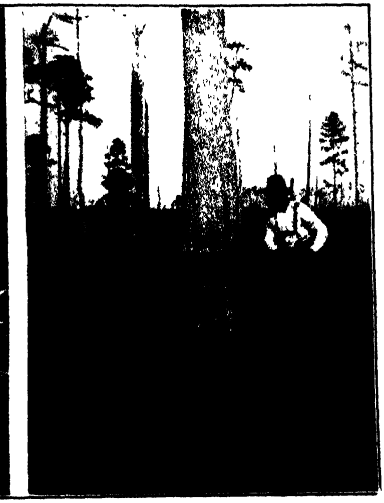
FIG. 1.



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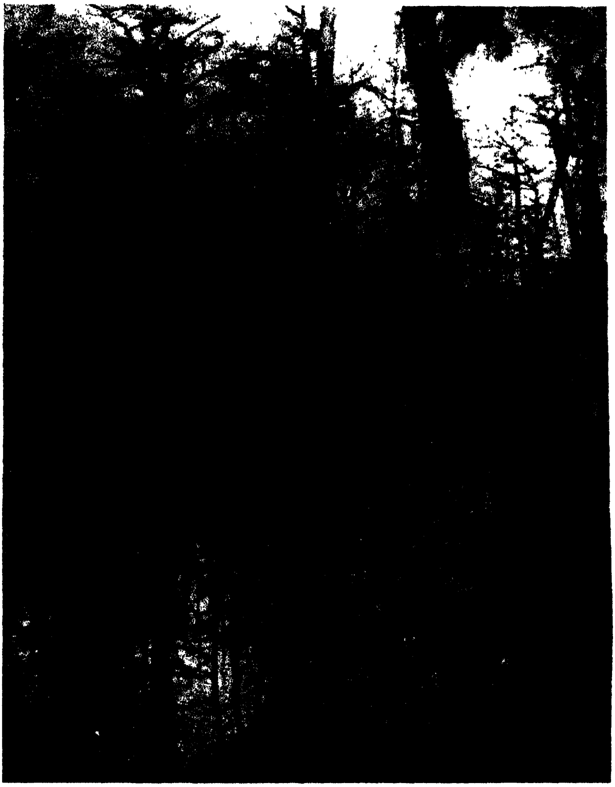

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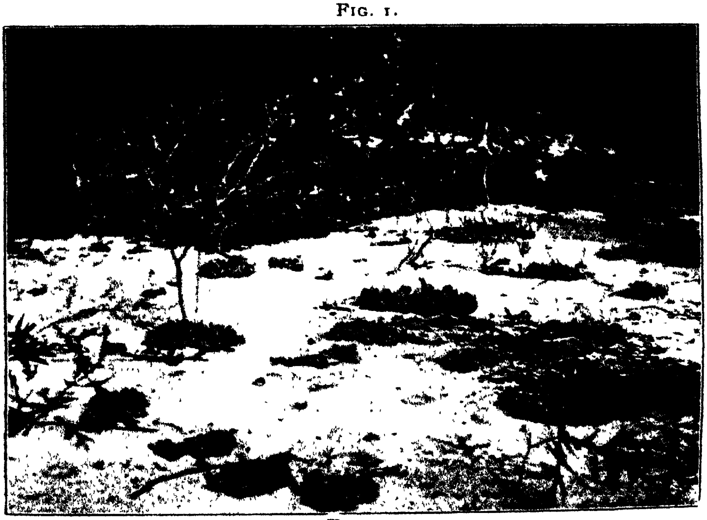

FIG. 2.

ANNALS

NEW YORK ACADEMY OF SCIENCES

VOL. XVII, PART II, SEPTEMBER, 1907.

[ANNALS N. Y. ACAD. SCI., Vol. XVII, No. 2, Part II, pp. 415-436.

THE ORIGIN OF VERTEBRATE LIMBS.

RECENT EVIDENCE UPON THIS PROBLEM FROM STUDIES ON PRIMITIVE SHARKS.

BY RAYMOND C. OSBURN.

For nearly thirty years the Fin-fold Theory has been commonly accepted to explain the origin of the limbs of the Vertebrata. This theory has as its main thesis that all fins, both paired and unpaired, have arisen *in situ* and in the same manner, as local developments from the body wall. Thus conceived, they are primarily external structures which have as their primitive form a longitudinal fold of skin supplied with muscles, nerves, and blood-vessels derived in a segmental way from the adjoining body wall, and with supporting structures which have had their origin within the fins. This theory first took form in the work of Thacher ('77), Mivart ('79), and Balfour ('78), all of whom arrived at the same conclusion independently, the first two on anatomical grounds, the last from the embryological standpoint. The theory has been ably supported by Dohrn ('83 and '02), Paul Mayer ('86), Wiedersheim ('92), Mollier ('93), Rabl ('01), Dean ('02), Regan ('04), and others.

Opposed to this view is the older "Archipterygium" or Gill-arch Theory, first definitely stated by Gegenbaur ('65 and '70) and maintained by him through all his later work ('95). Ranged on this side of the question are Bunge ('74), von Davidoff ('79 and '80), Fürbringer ('96 and '02), Braus ('98 and '04), and others of the Gegenbaur school. As far as the origin of the unpaired fins is concerned, the gill-arch theorists admit that they arose as local outgrowths, and go farther than their opponents in assuming a rigid metamerism of all the structures of the unpaired

fin, deriving the median fin skeleton from processes (dorsal and hæmal spines) of the axial skeleton, while according to the fin-fold theory the skeleton is supposed to have been developed independently of the vertebral column. But it is in the origin of the paired fins that differences of opinion are most in evidence, for while the fin-fold theorists consider that the paired fins have had in a general way a similar origin to the unpaired, the gill-arch theorists hold that they have been modified from gills and that the girdles and rays of the fins are directly homologous with the supporting structures (arches and rays) of the gills.

During all the years in which these theories have been under discussion unsettled points have not been lacking, and within recent time a number of objections have been urged against the fin-fold theory. With the hope of deciding some of these vexed questions and with a view to testing the validity of the objections raised, the writer has been led to investigate the development of the paired and unpaired fins of a cestraciont shark (*Heterodontus japonicus*, Duméril), a form belonging by direct lineage to a group of very ancient sharks,—much older, as far at least as can be judged by palæontological data, than any selachian that has hitherto been investigated.[1] For comparison the writer has had various stages of Spinax, Mustelus, and Torpedo, and has been especially fortunate in having access to a number of embryonic stages of *Chlamydoselachus anguineus* Garman, a form generally recognized as being one of the most primitive of modern Selachii. The series of Cestracion (Heterodontus) embryos at my command is very complete. For the use of all this valuable material my thanks are due to Professor Bashford Dean, to whom I am also grateful for much encouragement and many helpful suggestions in pursuit of the work.

The present paper embodies only the main results of my studies and will be followed by another more extended in scope, in which will be given the evidence upon which these results are based and in which the literature of the subject will be treated.

It may be briefly stated that the results of my work indicate that many of the objections raised against the fin-fold origin

[1] All references to Cestracion, Chlamydoselachus, and Spinax in the following pages are from my own observations, unless otherwise accredited.

of the paired fins apply equally well to the unpaired fins, which are held, even by those who have raised the objections, to be of strictly metameric and local origin. Other objections can be shown to be based upon faulty evidence, or upon facts which bear a different and more probable interpretation.

The principal objections to the fin-fold theory are, briefly stated, as follows:

A. Relating to the comparison of the paired fin girdles with gill arches the followers of Gegenbaur contend that:

I. The pectoral girdle arises in serial order with the gill arches.

II. The pectoral girdle makes its appearance earlier than the basalia and rays.

III. The basalia grow out of the girdles and the rays out of the basalia.

IV. The dorsal end of the pectoral arch comes into relation with the visceral muscles.

V. The pelvic girdle is the homolog of the pectoral in every respect and so corresponds to a gill arch.

B. Relating to the supposed migration of the paired fins from the gill region:

I. The pelvic fins have been shown to undergo slight migration or shifting during ontogeny.

II. As a proof of migration there appears a strong collector nerve in the anterior part of the pelvic fins.

III. Also, in the early development of the pelvic fin the most anterior muscle-buds degenerate without entering the fin, while those just posterior to these are compelled to reach backward to enter the fin.

C. Relating to the contrast of paired with unpaired fins:

I. The skeleton of the unpaired fins consists of modified vertebral (spinous and hæmal) processes.

II. The girdles of the paired fins have nothing to represent them in the unpaired fins.

III. The presence of post-axial rays in the pectoral fin proves the primitive biseriality of the paired fins.

IV. The fin-rays of the paired fins do not arise separately and later become fused to form basalia as the fin-fold theory would lead us to expect.

V. The fusion of the muscle-buds in the paired fins before the appearance of the skeleton precludes the possibility of the metameric origin of the latter.

VI. The early discrepancy between muscles and rays in the pelvic fin proves the primitive dysmetamery and independent origin of the paired fin skeleton.

Let us now examine the foregoing objections point by point and determine whether they are well founded.

A.

I. The pectoral girdle cannot be considered serially homologous with the gill arches for the following reasons:

(1) The first anlage of the pectoral girdle lies almost its whole length below the gill arches, as shown by Braus's reconstructions ('04) of Spinax, and by my own observations on Cestracion.

(2) It arises near the external wall of the body, while the gill arches arise near the pharyngeal wall, according to my studies on Cestracion.

(3) The thickening of mesenchyme from which the girdle is differentiated takes its origin next to the ectoderm and spreads in an inward direction till it occupies all the region in which the pectoral fin skeleton arises, which latter is therefore of external origin, since it arises out of this mesenchyme thickening. The gill arches, on the other hand, arise next to the enteron.

(4) The study of Cestracion shows that the first anlage of the pectoral fin lies wholly within the region of spinal muscles.

(5) In Cestracion at least, the pectoral girdle is relatively much farther from the last gill arch at its first appearance than it is during later growth. That is, it grows toward the gill-arch region.

(6) The first four points apply with even more force to the pelvic girdle which in a general way must be considered the homolog of the pectoral.

II. The observations of E. Ruge ('02) and Braus ('04) that the pectoral girdle of *Spinax niger* is the first part of the fin skeleton to make its appearance are probably not to be questioned, but since Spinax is the only form so far examined in which the time relations are thus, and as in Cestracion, which

is unquestionably a much older type of fish, the first anlage of the skeleton undoubtedly makes its appearance in the region of the base of the rays and the neighboring part of the primary basal, we must conclude that this objection is at least not final. On the contrary, it seems plain from the evidence at hand that Spinax is the exception to the rule.

III. Against this objection we must weigh the following facts:

(1) The writer finds that in Cestracion the rays and basalia begin to appear before the girdle. Other investigators since the time of Balfour ('78) have found the same to be true in various species (Spinax excepted).

(2) The basalia and rays do not "grow" out of any pre-existing structure, but are differentiated, both in the same manner, out of the same band or layer of mesenchyme. This layer gives rise also to the rudiment of the girdle. The above distinction is an important one since upon it depends the interpretation that all of these skeletal structures of the fins are developed *in situ* by differentiation instead of "growing out." The latter term implies internal development and change of location during the process, a condition contrary at least to the present observations.[1]

IV. The fact that the dorsal end of the pectoral girdle has relations with the visceral musculature (trapezius group, innervated by viscero-motor nerves), has been interpreted by the gill-arch theorists to show a primitive connection,—"die alten Relikte der einstmaligen kopfmuskelversorgung des Schultergürtels" (Fürbringer '02). The connection is beyond question, but that the above conclusion is not final is evident from the fact that in Cestracion the first anlage of the pectoral girdle arises entirely ventral to that anlage of the trapezius, quite separated from it, and comes into relation with the visceral muscles only by its later dorsal growth. This is true also of Spinax, as shown by my preparations of a 20 mm. embryo.

[1] By way of comparison, it is worthy of notice that the muscle-buds do grow into the fins. They disarrange the mesenchyme cells and push them out of the way during their progress. Nothing of this nature takes place in connection with the development of the fin skeleton.

V. The pelvic girdle cannot be strictly homologized with the pectoral, point for point, for the following reasons:

(1) In the oldest fossil sharks in which the pelvic is sufficiently known (Pleuropterygidæ) there is no pelvic girdle developed beyond the condition of basalia. If the gill-arch theory were true, the pelvic girdle should be best developed in the oldest forms.

(2) In the lowest modern sharks (Notidanidæ) there is in the adult no evidence of a dorsal prominence in the pelvic to correspond with the scapular portion of the pectoral. It is difficult to see how the pelvic girdle of Chlamydoselachus, a long, flat plate pierced with eight nerve foramina, could be made to homologize with the pectoral girdle of any shark.

(3) In none of the stages of Chlamydoselachus in my possession in which the pelvic is sufficiently developed (from 110 mm. upward) is there any indication of a dorsal prominence. The pelvic girdle develops as a flat basale-like plate.

(4) The argument for the anterior prominence which is present in some sharks and which was originally homologized with the scapula by von Davidoff has already been given up by the gill-arch theorists. The small dorsal prominence recently described (Braus '04) in the pelvic of Spinax and homologized with the scapula can scarcely be considered homologous, for the reason that it is situated posterior to the nerve foramen, while the scapular portion of the pectoral girdle is always, so far as my observations have extended, anterior to the foramen.

The various parts of the pelvic girdle cannot, therefore, be homologized with all parts of the pectoral, and certainly the pelvic girdle is much farther removed from comparison with the gill arch.

B. It becomes evident that no migration yet shown is quantitatively sufficient to account for the distance between the pelvic fin and the gill region, for:

I. The slight measurable migration which the pelvic may undergo in its ontogeny cannot be accepted as evidence in favor of migration from the branchial region.

(1) The pelvic fin in some cases migrates forward during ontogeny.

(2) The supposed demonstration of migration in the pelvic fin at an early period is better explained as due to the concentration of the fin from a longer basis, as I will show under another heading.

(3) The migration of the pelvic, as well as of other fins, has been shown biometrically to occur in accord with the shifting of the center of gravity during development (in Cestracion by Dean '02). By the same method it has been proved that the pelvic shifts its position in correlation with the dorsals (in Spinax by Punnett '04). Hence the observed migration becomes merely an adaptive process without any special meaning in phylogeny.

(4) While we have no direct evidence that any fin has ever migrated backward to any extent, we have abundant proof of the migration of the pelvic fins forward in many Teleosts, in extreme cases to a position in front of the pectorals. This, also, can be due only to adaptation.

(5) No satisfactory reason has ever been offered why a fin when once in the most important place in the body, viz. the pectoral position, should ever have migrated out of it into a region of such minor importance as the pelvic fin occupies in sharks and other primitive fishes.

II. The argument based upon the collector nerve is negatived at once by the following facts:

(1) Collector nerves appear also in the unpaired fins, both in the anterior and posterior parts of the fins, as Paul Mayer ('86) showed in Acanthias, Heptanchus, and Centrophorus, and as my own observations show in the first and second dorsals of Cestracion. Yet it is contrary to the Gegenbaurian conception of the unpaired fins that they have migrated at all in their phylogeny.

(2) A small posterior collector is known in the pelvic fins of certain species. This is assumed by the gill-arch theorists to be due to a secondary migration of the fin in a forward direction. However, the results of Punnett's studies ('00) on Mustelus indicate that in this species the pelvic fin of the female migrates farther forward than that of the male and yet has no posterior collector, while that of the male, which indicates less migration, none the less possesses it.

(3) In those Teleosts which show a migration of the pelvic to a thoracic position, the nerves of the fin are carried forward during the process, while no nerves are picked up on the way and no new collector is formed as a result of the migration.

The hypothesis of migration is therefore very far from meeting all the conditions. The only adequate explanation (Mollier '93) is that all the fins have shortened up at the base and have formed the collectors by bringing together nerves which once entered separately to innervate the longer fin. In favor of this view we have direct evidence that the fins of modern sharks do shorten up at the base during ontogeny, and we know also that the fins of the oldest fossil sharks (Pleuropterygidæ, Acanthodidæ, and Diplacanthidæ) were of the fin-fold character, broadest at the base and without any posterior indentation or notch such as modern selachian fins possess.

III. The facts of the degeneration of the most anterior muscle-buds, and of the backward extension of those buds immediately posterior to these to enter the fin, can not be accepted as proof of the migration of the fin, as has been so strongly urged by the gill-arch theorists (Braus '98), for:

(1) The same process occurs at the posterior border of the same fin. The observations of Braus ('98) demonstrate that in Spinax the last pelvic muscle-bud degenerates without entering the fin, while the buds immediately in front of it are compelled to reach forward to enter. My preparations of Spinax show that four such buds extend forward to attain their positions in the fin, and the same condition is observed in Cestracion.

(2) But, most significant, the same process, I find, occurs in the unpaired fins. In the dorsal fins of Cestracion the most anterior buds extend backward while the most posterior reach forward to enter the fin. Again, in Paul Mayer's work ('86) published more than twenty years before this objection to the fin-fold theory was raised, we learn from his description of the unpaired fins of Scyllium and Pristiurus that there are abortive muscle-buds both before and behind the dorsal fins, and we may observe from his plates that the most posterior

and most anterior buds which enter the fins have to reach out of position to accomplish it.

(3) The fact that in the pelvic fin these most anterior muscle-buds are the earliest to appear is not to be taken as a proof that they are phylogenetically older than those which appear later, as the gill-arch theorists assume (Braus '98), but, rather, they appear first because they are most anterior, for it is in the nature of all such serial structures to develop from anterior to posterior, *e. g.*, gills, somites, pronephric tubules, etc.). This condition is observed in the unpaired fins as well as in the paired, for in the dorsals of Cestracion the most anterior buds are the first to develop. The same principle, according to my observations, holds also among the various fins, the pectoral preceding the pelvic, the first dorsal preceding the second, in time of development, etc., yet this cannot be considered a proof that the first dorsal is phylogenetically older than the second nor the pectoral older than the pelvic. (According to the gill-arch theory the pelvic should be the older, yet it develops later than the pectoral.)

These facts are readily interpreted on the hypothesis that the bases of the fins once extended over a larger number of body segments than at present. In the pelvic it is evident that the shortening has been much greater at the anterior than at the posterior edge of the fin. As a result the present fin is now situated in advance of what was once its posterior limit, though the anterior edge of the present fin is much farther back than formerly. Certainly this is not migration, but a concentration of the fin basis in a manner similar to that occurring in the unpaired fins.

C. If the six objections given under this heading can be answered, the paired fins should be compared rather than contrasted with the unpaired fins.

I. If it were true, as the opponents of the fin-fold theory maintain, that the skeleton of the unpaired fins consists of modified spinous and hæmal processes, then evidently the skeleton of the paired fins could not have a similar origin to that of the unpaired. Opposed to such a view, however, are the following facts:

(1) In the first and second dorsals, the anal, and the superior

caudal fins there is not the least indication of such a close relation of the rays to the vertebral processes as we should expect from the above view of their origin. In the lowest sharks, especially in such forms as do not possess fin spines, the rays of the dorsal and anal fins are usually widely separated from the axial skeleton, according to the present studies on many species. In the ancient fossil shark Cladoselache, also, the rays of the dorsal fin are widely separated from the vertebral column.

(2) In ontogeny the skeleton of the unpaired fin is plainly developed from a plate of thickened mesenchyme which first appears next to the ectoderm.

(3) During early development the unpaired fin skeleton is never in contact with the axial skeleton, as shown by my studies of Cestracion, Chlamydoselachus, Spinax, Mustelus, and others.

(4) The only exception to the last statement, and the only case where corresponding rays are known to come into contact with vertebral processes, are found in the inferior caudal fin, and even here there are frequent discrepancies. This fin is then an exception to the rule, and if all the unpaired fins have had a similar origin, as seems probable, we must explain the condition in this fin as due to secondary fusion of the rays with hæmal spines to secure better support. On account of their mechanical relation to the ventral lobe of the caudal fin, which is the chief organ of propulsion, these rays stand in need of just such support. (This is the part of the fin which becomes the functional caudal in Teleosts.) Examples of parallel cases are the dorsal spines of sharks (undoubted secondary structures), which, in order to secure firmer support, have become secondarily attached to the axial skeleton, and the superior rays of the secondarily diphycercal tail of Dipnoi.

II. With regard to the comparison of the girdles of the paired fins with the basalia of the unpaired fins a number of facts present themselves.

(1) The girdles exhibit so much variation in form that they show themselves to be adaptive structures such as the basalia of unpaired fins are admitted to be.

(2) In the fossil Cladoselache we have the evidence that the pelvic girdle was formed in the same way as the basalia of unpaired fins,—indeed it is in the same condition as many of the unpaired fins of modern sharks.

(3) In the Notidanidæ, which are without doubt the lowest and most primitive of recent sharks, the pelvic girdle is merely a flat plate, not more complicated in form than the basalia of many unpaired fins, and in Chlamydoselachus twelve of the twenty-five rays of the pelvic fin attach directly to the girdle, thus indicating its primitive position in the category of basalia.

(4) In the more primitive Ganoids the skeleton of the paired fins has a close resemblance to that of the unpaired, as Thacher and Mivart demonstrated long ago. Regan ('04) has recently brought forward a remarkably clear case in *Psephurus gladius* in which the series formed by the anal, pelvic, and pectoral is most convincing. The pelvic resembles the anal even more than it does the pectoral.

III. The presence of post-axial rays in the pectoral fins of the fossil Pleuracanthus, and to a limited extent in modern selachians, is held by the gill-arch theorists to prove the "primitive biseriality" of the paired fin skeleton. Opposed to this conclusion we have the facts:

(1) The fossil Pleuropterygidæ, Acanthodidæ, and Diplacanthidæ, all of which occur in older strata than does Pleuracanthus, have the fins all decidedly of the fin-fold type, with not even any opportunity for the presence of post-axial rays.

(2) Post-axial rays are entirely absent from the pelvic fins of all sharks, modern and ancient (unless we are to accept the questionable cartilages in the mixipterygium of Pleuracanthus, the homology of which with post-axial fin-rays is at least doubtful.)

(3) The occurrence of post-axial rays in the pectoral fins of recent sharks is so sporadic and variable, and they are wanting entirely in so many species, that they are better considered as adaptive structures without peculiar phylogenetic significance.

(4) There are known cases of post-axial rays in the unpaired fins (dorsal of Raja, anal of Heptanchus; also the dorsal of the Devonian Ganoid, Cœlacanthus), where they have all the

appearance of those in the pectoral. This again shows their adaptive nature.

(5) In higher vertebrates which have taken up aquatic life we have well-known examples of extra or supernumerary digits formed adaptively on the post-axial side of the limb. This in the whales is proved to have taken place by a longitudinal division of the fifth digit (Kükenthal '88 and Symington '06). A migration of the fifth digit into a well-marked post-axial position for adaptive purposes is also well illustrated in certain aquatic reptiles and mammals, as I have elsewhere indicated (Osburn '06).

IV. Kerr ('99) pointed out that the real stumbling-block for those who have found themselves unable to accept the fin-fold theory lies in the fact that the fin-rays do not arise separately and later become fused to form the basalia. However, when we examine the mode of formation of the fin skeleton this difficulty disappears. It must be noted that the skeleton structures of the fin are the last of all to develop, and that the fin already has approximately its permanent shape when the skeleton begins to take form. It consequently makes its appearance as an adapted structure, suited to the mechanical needs of the fin at the time it develops. In the unpaired fins, which the gill-arch theorists consider primitively metameric, the process is precisely similar to that in the paired fins. Wherever, in the unpaired fins, the rays have become joined to form basalia, these basalia are present from the first, according to the writer's studies, just as they are in the paired fins, and they are not formed by the fusion of separate rays. There is, then, no more difficulty in accepting the origin of the paired fin basalia from rays than there is in accepting such an origin for the unpaired fins, since both proceed exactly alike. In neither case is there any fusion of once discrete rays to form basalia, but in both the basalia are adaptively formed as such from the first, due to the failure of the mesenchyme to differentiate into smaller elements.

V. The opponents of the fin-fold theory have lately insisted (Fürbringer '02, Braus '04) that the fusion of the muscle-buds described by Mollier ('93) in the paired fins proves the original dysmetamery of the paired fin skeleton, since the fusion to

form the "musculi radiales" takes place before the appearance of the rays.

The writer's investigations on Cestracion show conclusively that such an argument cannot be considered valid, for the reason that fusion occurs also in all the unpaired fins, which are held by the gill-arch theorists to be strictly metameric. I have carefully traced the process from its inception and compared it with the same process in the paired fins and there is no observable difference. On the other hand, it only shows more clearly the close relation of the paired and unpaired fins.

VI. The discordance or discrepancy between muscles and rays which has also been strongly urged as proof of the primitive dysmetamery and independent origin of these structures in the paired fins (Braus '04) has likewise no place in argument against the fin-fold theory, for again the same condition is found to occur in the unpaired fins. My reconstructions of the first and second dorsal fins of Cestracion show the same sort of discrepancy that has been proved to exist in the paired fins.

In the foregoing pages the objections to the fin-fold theory have been considered; we may now mention the following objections to the gill-arch theory:

I. The indications are that the primitive fin possessed a far greater number of rays than the primitive gill.

II. There has never been discovered any indication of an intermediate stage representing a transition from the gill to the fin.

III. My observations indicate that the paired fin girdles have not been abstracted from the branchial region by the spinal muscles in the manner assumed by the gill-arch theorists.

IV. The gill-arch theory violates important time and place relations.

To further explain these statements:

I. The gill-arch theorists have tried to show that the gill rays have degenerated, and they reason that at one time the gill might have had rays enough to equal those of the primitive fin. The only evidence of degeneration thus far produced has been in the hyoid arch, the rays of which are reduced somewhat

in number, but that is no indication that the number of rays in the true gills has been diminished by more than one-half. Certainly in Cestracion there is no evidence of any reduction in the number of rays in the true gills.

II. It would seem that, if the paired limb had been derived in the way the gill-arch theorists maintain, there should remain in ontogeny some indication of the intermediate steps through which the gill passed while becoming a fin. That no such steps are known to occur in embryology, palæontology, or comparative anatomy is a very forcible argument against such an origin of the fins.

Fusions of gill rays resembling somewhat by their branching structure the basalia and rays of a fin have been described in sharks (Braus '04). However, the only cases of this kind thus far made known have occurred in the hyoid arch, and even the most sanguine adherent of the gill-arch theory would scarcely maintain that the hyoid is progressing in the direction of becoming a fin.

III. Because both the spinal and the visceral (trapezius) muscles attach to the dorsal end of the pectoral arch, we are hardly justified in supposing that the one is abstracting it from the other. Yet on this basis the gill-arch theorists assume that the anterior spinal muscles not only deprived the branchial region of the pelvic arch but passed it over to their neighbors and proceeded to abstract another. Why this kleptomania should have been satiated with two arches, while half a dozen yet remained, does not appear.

If the above assumption were true, it might indeed make a strong argument for the gill-arch origin of the paired limbs, but that it is without foundation appears in the light of the following facts in selachian embryology:

(1) As we have shown, the pectoral girdle is differentiated from a thickening of mesenchyme cells which grows inward from the region of the epidermis.

(2) According to my observations on Cestracion and Spinax, the first anlage of the pectoral fin is situated entirely ventral to the place of origin of the trapezius muscle, and it is by the later growth of both these structures that they finally come

into contact. The connection must, therefore, be interpreted as secondary.

(3) The pectoral girdle of Cestracion as it develops moves toward the gill region. When it first appears, the scapular portion of the girdle is separated from the last gill arch by a considerable space, but as development proceeds the girdle and the arch approach each other until the intervening space is eliminated. At first this space is fully twice as great as that between the gill arches; at 35 mm. it is half passed over, and at 60 mm the arch and girdle are practically in contact. In the adult they overlap slightly.

There is, moreover, no evidence that gill arches may be crowded or pushed out of the branchial region. It has, on the other hand, been proved that the sixth gill of Cestracion degenerated *in situ*, if the structures which Mrs. Hawkes ('05) describes are to be interpreted as the vestiges of a gill arch.

IV. First, as to time relations, it is important to note that all the other structures of the fin make their appearance in advance of the skeleton, and before the gill arches are differentiated On the assumption that the fin has been formed out of a displaced gill, we should expect to find the skeleton developing in an outward direction and carrying with it the other structures which form the fin. But instead of this, the fin fold, with its muscle-buds, nerves, and blood-vessels, as well as the primitive support of the fin (the mesenchyme thickening), is well developed before the skeleton becomes evident. Moreover, the fin skeleton does not grow into the fin fold, for there is no disarrangement or shifting of parts as the skeleton appears, but the skeleton forms *in situ* by differentiation of the original mesenchyme support. This is just as it should be on the fin-fold theory, but exactly opposite to what would be expected on the gill-arch theory, if time relations stand for anything. The order of appearance, furthermore, is precisely as it is in the unpaired fins.

Second, with regard to place relations, we have already shown that the first rudiment of the pectoral arch is more ventral than that of the gill arch, that it is more external, and that in Cestracion at least it grows toward the gill region as it develops.

A number of arguments in favor of the fin-fold theory yet remain, and may be summarized as follows:

I. All fins of sharks arise as longitudinal folds of the epidermis.

II. The muscle-buds which give rise to the muscles of the fins originate exactly alike in both kinds of fins.

III. The nerves which supply the paired fins take their origin in the same way as those of the unpaired.

IV. The origin of the blood supply is alike in both kinds of fins.

V. The earliest support of the fins, a plate of thickened mesenchyme, is of the same character in paired and unpaired fins and arises in the same manner in both.

VI. The time, place, and manner of differentiation of the fin skeleton is similar in all the fins.

VII. The later growth of the fin fold and the constriction of the fin at its base are similar in paired and unpaired fins.

VIII. Fusion of rays, basalia, etc., occur sporadically as well as regularly in the fins of both categories.

IX. Fin spines are known in both kinds of fins.

X. Ceratotrichia or horny dermal rays are present in all the fins of sharks.

Examining the above arguments in the order given:

I. Whether or not the longitudinal folds which give rise to the fins have once been entirely continuous is a matter of no great consequence,—though it seems entirely possible from the evidence at hand that the fins may have been connected in their early history. Be that as it may there is no disputing the fact that all the fins of sharks, and indeed of practically all fishes (the only known exceptions are very rare and embrace forms of highly specialized development, *e. g.*, Lepidosiren, Gambusia), originate as folds of skin. It must be noted that these folds are always longitudinal. The gill membrane, which may be considered the homolog of the fin according to the gill-arch theory (since it contains the rays of the gill), is, on the other hand, vertical in origin. If time and place relations have any meaning in embryology we cannot avoid the conclusion that the most primitive ancestral fin was a fin fold. Add to this the evidence

from the oldest fossil sharks (Pleuropterygidæ, Acanthodidæ, and Diplacanthidæ) and we have a clear case.

II. The muscle-buds supplying the fins on the dorsal side of the body arise from the dorsal ends of the myotomes, while those supplying the fins on the ventral side, paired and unpaired alike, arise in exactly the same manner from the ventral ends of the myotomes. There is nothing in this process to indicate otherwise than that the fins have arisen *in situ* as outgrowths from the body wall.

III. The fins on the dorsal side of the body are supplied by branches of the dorsal rami of the spinal nerves, the same in character as those which supply the adjoining parts of the body, while on the ventral side, paired and unpaired fins alike are similarly supplied with branches of the ventral rami.

IV. In the embryology of Cestracion I have carefully followed the development of the blood supply in both kinds of fins. In every case the blood-vessels are those which also supply the adjoining body wall, and which take their origin as dorsal branches of the dorsal aorta, or, in other words, are typical body wall blood-vessels.

V. The earliest support of the fins, paired and median alike, is, as we have already stated, a dense or thickened mesenchyme. The thickening in all cases begins next to the ectoderm and becomes noticeable immediately after the fin fold makes its appearance. As growth progresses this denser mesenchyme extends inward until it occupies all of the region in which, later on, the fin skeleton is formed. The procartilage is differentiated right in place out of the mesenchyme support, and later becomes chondrified to form the cartilaginous skeleton. This sequence in development is just what the fin-fold theory would lead us to expect, and it seems altogether probable that such has been the phylogenetic history of the supporting structures of the fins.

VI. In Cestracion the first indication of the formation of the skeleton is seen in the region near the middle of the fin, and the bases of the rays and the adjoining portions of basalia appear at the same time and are the first structures to be observed. The differentiation spreads in all directions, and the

girdles, in the case of the paired fins, appear very rapidly. In the unpaired fins the process is identical, except for the girdles. We must insist upon the fact that the rays do not "grow out" of the basalia but that both structures are differentiated in the same way out of the same mesenchyme plate. Similarly the girdles do not grow out of the basalia, nor *vice versa.*

VII. As we have seen, the fin fold originates in precisely the same way in paired and unpaired fins. The process of further development is also similar in both. The base of the fin grows relatively slowly, while the body is elongating and the external part of the fin fold is pushing out very rapidly. This results in a concentration of the fin base, in the manner described by Mollier ('93) for the paired fins. The median fins pursue a similar course, though usually the process is not carried to such a degree. The shape taken by the fins during development depends upon what Mollier has termed their "direction of growth." The amount of constriction at the base of the fin is presumably measured by the amount of mobility required of the fin.

VIII. The so-called "fusions" of rays and basalia, which, in reality, are merely failures to differentiate separately out of the mesenchyme and are not due to the growing together of parts, may occur at any part of the fin skeleton, but according to my observations made on many preparations, as well as on data provided by the plates of various authors, they occur much more commonly at or near the ends of the series of rays. It would seem that mechanical conditions would naturally be most effective in producing them here. The mode of formation of these "fusions" and the manner of their occurrence, both of which are similar in all fins, lead us to conclude that they are of one kind with the larger basalia and that all such sporadic as well as regular cases are produced in adaptation, *i. e.*, to meet the mechanical needs of the particular fin in which such structures occur.

IX. While spines are not found in the paired fins of modern sharks, they are to be found in those of some of the oldest fossil forms (Diplacanthidæ and Acanthodidæ, also Gyracanthus, Haplacanthus, and Heteracanthus). This shows the very

similar nature and potentiality of the two kinds of fins at a very remote period,—Upper Silurian and Devonian.

X. Horny fin-rays or ceratotrichia are very characteristic structures of the fins of sharks and occur nowhere else in the body. The importance of these structures in phylogeny has recently been discussed by Goodrich ('04) who finds them to be very ancient and very conservative. They occur alike in the paired and unpaired fins of all sharks, even the most ancient. (Goodrich's failure to find the ceratotrichia in the paired fins of Cladoselache can be attributed only to insufficient material, for an examination of the many specimens in the American Museum of Natural History proves their presence beyond a doubt.) As these structures occur equally in every respect in all the fins, and develop in the same way and at the same relative time, they may be taken to indicate a community of origin for all of the fins.

When we consider the facts derived from embryology, anatomy, and palæontology which are arrayed in the preceding pages, the conclusion is borne in upon us that the paired and unpaired fins are primarily similar structures, and the evidence from the present investigations is overwhelmingly in favor of the origin of all fins as local outgrowths from the body wall.

Columbia University, New York City,
March 28, 1906.

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THE ORDERS OF TELEOSTOMOUS FISHES.

A PRELIMINARY REVIEW OF THE BROADER FEATURES OF THEIR EVOLUTION AND TAXONOMY.

BY WILLIAM K. GREGORY.

In the course of their teaching work at Columbia Professors Osborn and Dean have realized the need of students for a brief general review of the evolution of the Vertebrata, in so far as this may be inferred from the hard parts of existing and fossil forms. The preparation of such a work was undertaken in 1902 by Professor Osborn with the assistance of Dr. J. H. McGregor, and in 1904 the present writer was commissioned to work up the material for the section on the Ganoids and Bony Fishes. The following preliminary review of these forms is published with the hope of eliciting the suggestions and criticisms of ichthyologists. It is largely based upon the well-known writings of Smith Woodward, Boulenger, Gill, Jordan and Evermann, and Jordan, to whom most of the statements of fact should be credited, and it is also intended in the main to reflect the views of those authorities. But many other sources are drawn upon; the method of presentation is not the conventional one, and the classification adopted (after considerable reflection) is believed to reconcile the marked differences in method in the American and English systems. The writer is under obligations to Dr. O. P. Hay for certain valuable suggestions and criticisms and to Professors Henry Fairfield Osborn and Bashford Dean, his esteemed preceptors, for the general methods of analysis.

The student seeking a general knowledge of the teeming hosts and almost endless structural modifications of the teleostomous fishes is at present confronted by two very distinct systems of classification: the American system, as exemplified in the latest classification adopted by President Jordan,[1] and the new

[1] *A Guide to the Study of Fishes*, 2 vols., 4to, New York 1905.

English method of Dr. G. A. Boulenger.[1] The discovery of the reasons for this divergence in method, of the common grounds upon which both systems rest, and of a means of harmonizing these differences in a new or compromise classification, may be facilitated by a glance at the recent history of the taxonomy of fishes, and by a brief reference to some of the principal functions of "natural" classifications in general.

First, as to the history of systematic ichthyology.

In England Günther's[2] classification was long held as orthodox. It represented more especially the combined labors of Cuvier, J. Müller, Agassiz, and Günther himself, and was essentially pre-evolutionary in method. The larger groupings were fairly natural, but many of the smaller ones were really heterogeneous, and held together by homoplastic characters. The chief criteria of classification were external characters.

In America Cope and Gill approached the subject from the standpoint of evolution. Cope[3] in 1871 sketched out the broad lines of a new classification based on a careful study of a large osteological collection. This classification was founded to a large extent upon internal, skeletal characters. As compared with previous systems it was also founded on a larger number and range of characters and was thus less subject to the deceptive effects of characters resulting from convergent or parallel evolution.

Gill[4] had already recognized the naturalness of the assemblages called by him Nematognathi, Eventognathi. In 1872 Gill published his "Arrangement of the Families of Fishes"[5] which was revised and extended in his memoir[6] of 1893.

[1] *Teleostei* (Systematic Part), *The Cambridge Natural History*, vol. "Fishes, Ascidians," etc., 1904, pp. 539–727.

[2] *An Introduction to the Study of Fishes*, 8vo, Edinburgh, 1880, pp. xii–xvi.

[3] "Observations on the Systematic Relations of the Fishes," *Proc. Amer. Assoc. Adv. Sci.*, 20th meeting, Indianapolis, 1871, pp. 317–343.

[4] "Catalogue of the Fishes of the Eastern Coast of North America," *Proc. Acad. Nat. Sci.*, Phila., 1861, pp. 1–63.

[5] "Arrangement of the Families of Fishes, or Classes *Pisces*, *Marsipobranchii*, and *Leptocardii*," *Smithsonian Misc. Coll.*, No 247, 1872, pp. i–xlvi, 1–49.

[6] "Families and Subfamilies of Fishes," *Mem. Nat. Acad. Sci.*, Vol. VI, pp. 125–138.

In this classification which has been the basis of all subsequent work of the American school, precision, classicism, and a strict adherence to the canons of nomenclature reinforced a keen analysis and a judicious weighing of taxonomic values. The attempt was made to readjust these values so that they might express more nearly the various degrees of affinity, and to introduce more uniformity in the value assigned to the same taxonomic grade in different groups of vertebrates. Many currently recognized families were variously divided, the component parts being elevated to the rank of separate families, while many groups were labeled "of uncertain position." The dictum that "analysis must precede synthesis" was consistently followed, and a great increase in the number of ordinal, subordinal, and family divisions was deemed preferable to the premature groupings of the traditional classification. Attention was in this way directed to the very numerous families and groups which were really of uncertain affinities, but which had always been thrown in with other divisions by the conservatism which resents the introduction of new groups and new names. An important synthetic step was the frequent use of the superfamily.

In England and on the Continent the Güntherian system was gradually found inadequate, and the importance of the skeleton in classification became recognized as ichthyology and especially palæichthyology developed. Dr. A. S. Woodward adopted the broad features of Cope's classification, which he improved in many respects, but the older system still remained in general use. The new and very notable classification of Dr. Boulenger, referred to above, is the first since that of Günther to gain general acceptance in England. Dr. Boulenger refers [1] to the classification of Günther as being to a "great extent based on physiological principles," whereas his new classification "aims at being phylogenetic." It is based upon his studies of the rapidly growing collection of fish skeletons in the British Museum; it reflects also the labors of Cope, Gill, Sagemehl, A. S. Woodward, of Jordan and his co-workers, and thus represents the most comprehensive analysis of osteological characters which has yet appeared.

[1] *Op. cit.*, p. 542.

Boulenger's classification is true to British tradition in the fewness of its larger divisions; and many families, suborders, and orders of the American system are not recognized as distinct divisions. Thus the differences between the English and American systems are very salient. By the American method as exemplified in Dr. Jordan's latest work, 18 orders, about 33 suborders, and considerably more than 200 families of true Teleosts are recognized; by the English method all are swept into the single "order" Teleostei which is coördinate in value with the orders Crossopterygii, Chondrostei, Holostei, and which is subdivided into thirteen suborders which for the most part have the value of the orders of the American system. Boulenger's treatment of the "suborder" Ostariophysi may serve as an instance of this extensive synthesizing. Since this assemblage is regarded as a natural one the divisions Heterognathi, Eventognathi, Nematognathi are not used, and the Characins, Carps, and Catfishes are all united as families in the suborder Ostariophysi. In Boulenger's definitions of these families the trenchant structural differences between them are revealed, but so far as the classification itself indicates they might be no more separated than, say the Tarpons (Elopidæ) from the Lady-fishes (Albulidæ), or the Herrings (Clupeidæ) from the Salmons (Salmonidæ).

These differences in method seem to arise from the dual nature and function of a natural classification in the modern sense. A natural classification must necessarily express, first, degrees of homological resemblances and differences and, second, degrees of genetic relationship; but it cannot at the same time express both with equal accuracy, and its *primary* purpose is to express degrees of homological resemblances and differences.

In comparing the end forms of diverging lines of descent we find that between any two forms degrees of *genetic* relationship are solely a function of time and of the rate of reproduction, while degrees of homologous structural relationships are a function of varying rates of evolution. To borrow an illustration from mammalogy, we may suppose that a certain group of pre-Tertiary mammals has given rise to the modern Insectivores on the one hand and to the Bats on the other. Between this ancestral group and each of the two modern groups a number

of generations has elapsed which we may assume to be roughly equal along both lines of descent. Therefore, in degree of blood kinship to this ancestral group both Bats and Insectivores are about equally far removed. But in homological structural resemblances the modern Insectivores are much nearer to this group than are the Bats, and hence so far as classification is concerned, the ancestral group and the Insectivores would probably be placed in a single order, while the Bats are set off in another order. Here plainly, *degrees of blood relationship do not exactly correspond to degrees of homological structural resemblances and differences*, nor to the divisions of classification.

In order to make classification correspond even roughly to degrees of blood relationship, *i.e.* to phylogeny, we must assign varying systematic values to different characters in proportion to their inferred relative phylogenetic age. For example, the notochord and other chordate characters which appear in certain larval Ascidians are regarded as of far greater phylogenetic age than the typical characters of adult Ascidians, and hence these transient characters are given a very high systematic value, so that through them the group is placed within the phylum Chordata. On the other hand neomorphs or "teleological" characters are given much lower systematic values. The unique sucking-disc of the Remoras, for example, which is believed to represent a modified spinous dorsal fin,[1] does not avail to remove the family beyond the borders of the order Acanthopterygii. In this way classification is roughly adjusted to phylogeny, but the adjustment can never be complete or exact.

These considerations reveal the general defects of both the American and English methods of classification. The American system may fail to emphasize the underlying affinities of structurally well-defined groups, as, for example, of the Nematognathi or Catfishes with the Plectospondyli or Characins and Carps. The English system emphasizes the larger phylogenetic affinities but may not give due value to the equally important structural diversities.

Again the English system seems to follow the general principle

[1] R. Storms, "The Adhesive Disk of Echeneis," *Ann. Mag. Nat. Hist.*, (6) II, 1888, pp. 67–76

that when intermediate forms between related groups are discovered, these connections of form and of kinship should be expressed by the assembling of the extreme forms and the middle forms in one group, usually without any higher subdivisions than families. Thus the Zeus-like fishes are thought to be related to the Flatfishes through the Eocene Amphistiidæ. Hence Boulenger abandons the groups Zeoidea, Heterosomata, and by an ingenious definition links the two in a new group called Zeorhombi.

Whether related groups are now continuous or discontinuous is partly an accident of time and of the degree of completeness of our collections of fossil and recent forms. Surely such terms as Nematognathi for the Catfishes, Squamipinnes for the Chætodonts and their allies, and many other useful group-names stand for perfectly clear types of structure, in forms clustered around central types but grading into other groups at the peripheries. The idea underlying the American method is that the best way to map out the topography of this varied morphological expanse is to assign a name to every conspicuous cluster of elevations, even if some lesser outlying elevations may connect with neighboring systems.

Thus the two classifications emphasize different sets of facts about the same subject-matter, so that in a general way the English method emphasizes better both resemblances and phylogeneti- gaps between different groups. Furthermore, as we have seen, the results of the two methods are expressed in terms of a standard the "order" which has a very different value in the two systems, in the English system covering the entire range of forms from certain generalized Triassic physostomes (the Pholidophoridæ) to the most advanced spiny-finned fishes and even to such wonderfully metamorphosed beings as *Mola* and *Malthe;* while in the American system the same term "order" implies a much narrower range, as for example in the Haplomi.

The American and English methods are fortunately not entirely irreconcilable or contradictory, not like the two horns of a dilemma between which only a bad choice is possible. Conceivably the differences may be adjusted, and all the antitheses and syntheses which the two systems seek to convey may be harmoniously expressed.

The first step is to note the necessity for a larger number of grades of taxonomic divisions between the subfamily and the class than is found in the English system, which deals only with the *order* (Teleostei), the *suborder*, the *division*, the *family*, and the *subfamily*. As degrees of homological resemblances and of phylogenetic affinities are infinite in number even a highly differentiated system of classification must be more or less Procrustean in nature, since in order to force all the different grades of assemblages into appropriate compartments some phylogenetic values must be relatively compressed and others somewhat stretched. But surely by using more grades of subdivision we may distort the facts less than by using fewer grades; although common sense must soon impose a limit to the increase in the number of grades, since each grade requires a corresponding set of terms throughout the system. One advantage of a highly differentiated system with many grades of divisions is that it permits us to retain on different taxonomic levels many old useful and expressive names such as Malacopterygii, Isospondyli, which if applied to divisions of the same taxonomic rank would compete with each other as synonyms.

The process of the differentiation of taxonomic grades has been going on for a long time in ichthyology and elsewhere, and it has usually been accompanied by the elevation in rank of certain taxonomic grades and the lowering in rank of others. Thus the rank of the grade called "species" by Linnæus has really been lowered, since many of his species are now called "genera" and his genera "families" while in Gill's system many of Günther's "families" were elevated to the rank of the division called by Gill "superfamily." From these inevitable shiftings many of the differences between the American and English systems have arisen.

The desirability of a highly differentiated system has suggested the use of the terms class, subclass, infraclass, cohort, superorder, order, suborder, division, superfamily, family, subfamily in the accompanying classification, which is offered as a tentative compromise between the American and English systems.

The only ones of these terms requiring special comment are the infraclass, superorder, cohort, and order. The infraclass is

a division recently suggested by Professor Osborn to express the relations of Marsupials to Placentals which together constitute the subclass Eutheria Gill (not of Huxley) in contrast to the subclass Monotremata. The differences between Marsupials and Placentals do not seem to be more deep-seated than the differences between the Crossopterygii on the one hand and the Actinopteri Cope (all the remaining Ganoids and Teleosts), on the other. Hence I regard the Crossopterygii and Actinopteri as infraclasses. Again the Dipnoi show many resemblances to the Crossopterygii in their comparative anatomy, embryology, and palæontology, and it seems advisable to express this relationship by ranking the Dipnoi as an infraclass, coördinate with the Crossopterygii and Actinopteri, the three groups being embraced within the subclass Teleostomi, a procedure already suggested in essentials by Gill.[1] After the exclusion of *Polypterus* and its allies from the Ganoidei, this classic term with its congeneric term Teleostei may be used in a perfectly clear sense as by Jordan and Evermann, for the upper and lower divisions of the Actinopteri. These divisions we may call *cohorts*, the cohort having been used by Storr in 1780 in the classification of the Mammals. The cohort Ganoidei may be taken to include the superorders **Acipenseroidei** Traquair, **Lepidosteoidei** (as understood by Bridge in *The Cambridge Nat. Hist.*, vol. "Fishes," etc.); the cohort Teleostei to include the superorders **Malacopteroidei** (embracing the orders Isospondyli, Ostariophysi), **Mesichthyes** (Hay) (embracing the orders Haplomi, Synentognathi, Salmopercæ), **Thoracostraci** Swinnerton (embracing the orders Hemibranchii, Lophobranchii), **Acanthopteroidei** (embracing the orders Percesoces, Anacanthini, Labyrinthici (?), Acanthopterygii, Selenichthyes, Tæniosomi, Plectognathi, Hypostomides, Opisthomi, Pediculati). The superordinal relationships of the eel-like orders Apodes, Symbranchii, Heteromi, whether to the Ganoid, Malàcopteroidei, or Mesichthyes are not clear.

It will be seen that the classification given herewith adheres to the American standard in regarding as orders such great groups as the Ostariophysi, the Acanthopterygii proper, the Haplomi,

[1] "Addresses in Memory of Edward Drinker Cope," *Proc. Amer. Philos. Soc.*, Memorial Vol. I, 1900, pp. 15, 16.

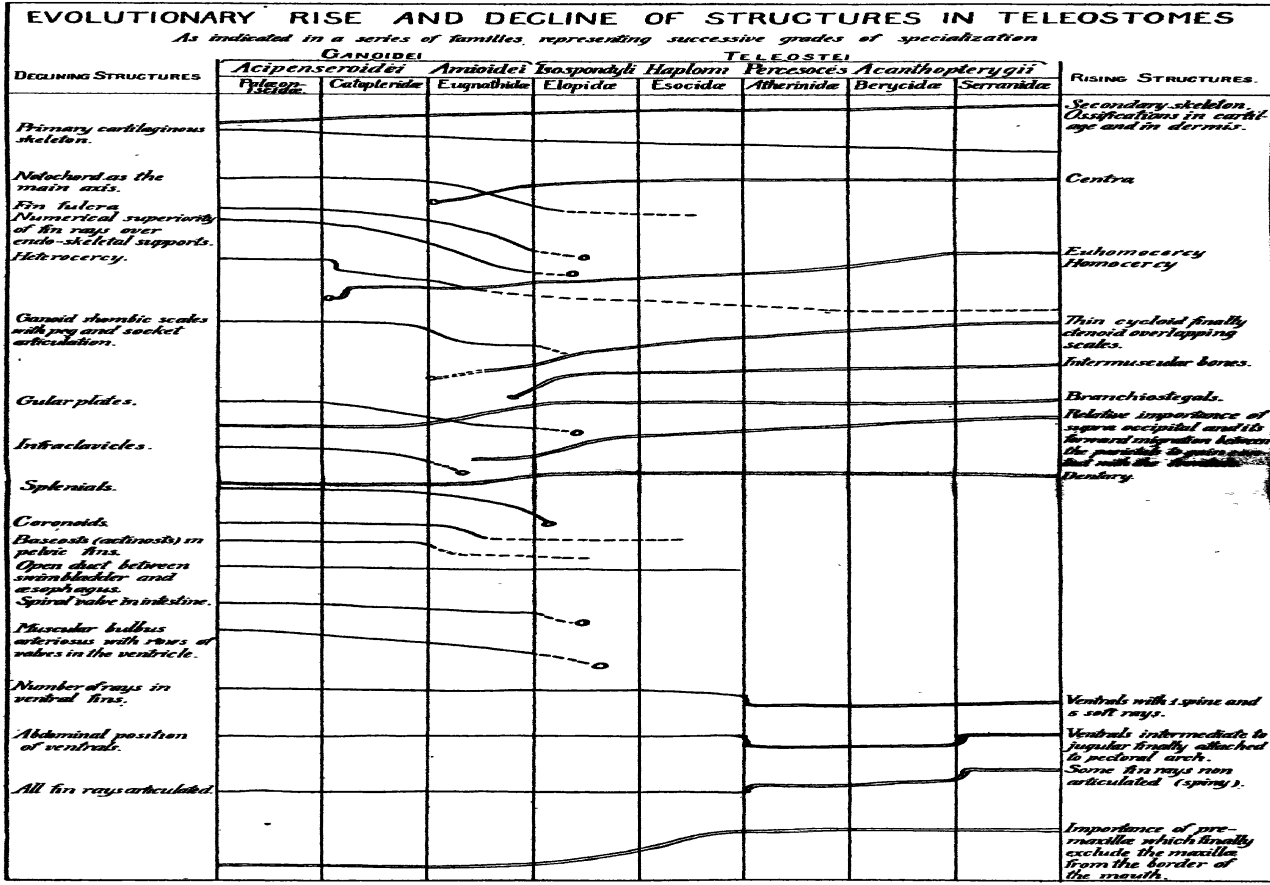

Plate XXX.—Evolutionary rise and decline of structures in Actinopterous fishes, as illustrated in a series of families representing successive grades of specialization (based on the researches chiefly of Smith Woodward and other authors cited under Plate XXIX).

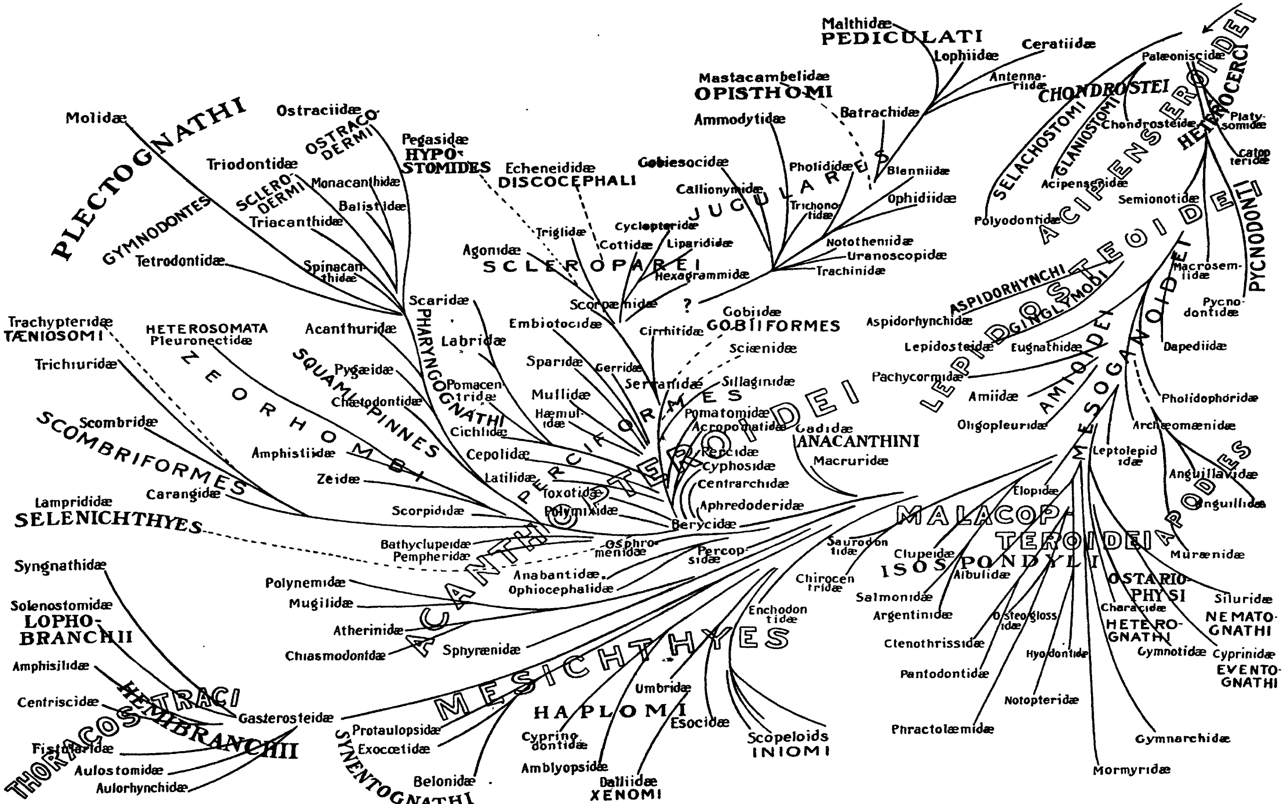

Plate XXIX.—Preliminary diagram of the phylogenetic relations of the principal families of Actinopterous fishes based on the classifications and analyses chiefly of Gill, Cope, Jordan and Evermann, Jordan, Smith Woodward, Boulenger, Zittel, Eastman, Hay, Starks.

The phylogenetic tree, which arises in the upper right-hand corner, is adapted to the available space by bending around some of the upper branches toward the right.

Isospondyli, etc., which seem in a general way to be of about the same rank as the orders of the Mammalia. Such divisions proposed by the American school as Squamipinnes, Beryçoidei, Percomorphi, etc., which often represent the breaking up of larger assemblages, have been frequently adopted, while on the other hand the synthetic results of the English system have been expressed in the present classification by the extensive grouping of families into superfamilies, of orders into superorders, and so forth. Fortified by considerable historic precedent, I have not hesitated to raise or lower the rank of various groups while retaining for them the old names. Gill's principle of keeping groups apart until they have been shown to belong together has also been kept in mind. In regard to nomenclature old and prior names have been retained wherever possible even where the limits of the groups designated have become considerably altered; whenever the "core" of an old group appeared to be natural that name, after its content had been amended, has been retained.

A CLASSIFICATION OF THE JAW-BEARING FISHES.

(Compare Plate XXIX.)

SUPERCLASS GNATHOSTOMATA
  CLASS PISCES
    Subclass **ELASMOBRANCHII** *Bonaparte*
      Superorder PLEUROPTERYGII *Dean*[1]
        Order **Cladoselachii** *Dean*
          Fam. Cladoselachidæ
        Order **Acanthodei** *Owen*
          Fam. Acanthoëssidæ
          " Acanthodidæ
          " Diplacanthidæ
      Superorder ICHTHYOTOMI *Cope*
        Order **Pleuracanthides** *Hay*
          Fam. Pleuracanthidæ
      Superorder PLAGIOSTOMI *Duméril*
        Order **Diplospondyli** *Hasse* (Opisarthri *Gill*, Notidani *Jordan*,

[1] The reasons for believing the Pleuropterygii to be related to the Acanthodei are given by Dean in *Journ. Morph.*, 1894, pp. 109–111. The structural divergence between the two groups seems to warrant the retention of the two orders as such.

Protoselachii) *Parker & Haswell*
Fam. Notidanidæ
" Chlamydoselachidæ

· Order **Prosarthri** *Gill* ("Les Cestraciontes" *Agassiz*)
Fam. Orodontidæ
" Heterodontidæ (Cestraciontidæ)
" Edestidæ
" Cochliodontidæ Inc. Sedis[1]

Order **Batidoselachii** (nom. nov.) ("Tectospondyli" (*Hasse*) Smith Woodward)
Suborder **Cyclospondyli** *Hasse*[2]
Fam. Spinacidæ (Squalidæ)
Subfam. Squalinæ, *Squalus*, (*Acanthias*), *Centrina*, *Centrophorus*, *Spinax*, *Centroscyllium*
" Scymninæ (Dalatiinæ), *Scymnus*, *Somnosus* (*Læmargus*)
" Echinorhininæ

Suborder **Tectospondyli** (*Hasse*)
Div. 1. Pristes Gill
Fam. Pristiophoridæ
" Pristidæ
Div. 2. Rhinobati (nom nov.)
Fam. Rhinobatidæ
" Tamiobatidæ[3] Inc. Sedis
Div. 3. Rhinæ Gill (?)
Fam. Rhinidæ (Squatinidæ)
Div. 4. Rajæ auct. (Pachyura Gill)
Fam. Rajidæ
Div. 5. Torpedines (nom. nov?)
Fam. Torpedinidæ (= Narcobatidæ)
Div. 6. Masticura (*Gill*)
Fam. Petalodontidæ Inc. Sedis[4]
" Psammodontidæ Inc. Sedis[4]
" Dasyatidæ (Trygonidæ)
" Myliobatidæ

Order **Asterospondyli** (*Hasse*) (Galei, Euselachii)
Superfamily Scylliorhinoidea (nom. nov.?)
Fam. Scylliorhinidæ (Scylliidæ)
Superfamily Lamnoidea (nom. nov.?)

[1] Possibly allied to the Petalodontidæ and Rays (Eastman).
[2] See Jordan, 1905, Vol. I, pp. 545-547.
[3] Devonian, possibly allied to Cestracionts (Jordan).
[4] Possibly allied to Cestracionts but more raylike in dentition.

Fam. Carchariidæ (Odontaspidæ)
" Mitsukurinidæ (Mitsukurina, Scapanorhynchus)
" Alopeciidæ
" Lamnidæ
" Cetorhinidæ
" Rhinodontidæ
" Sphyrnidæ
" Galeidæ

Superorder CHIMÆROIDEI[1] auct.
Order **Holocephali** *J. Muller*
Fam. Ptyctodontidæ
" Squalorajidæ
" Myriacanthidæ
" Menaspidæ
" Rhinochimæridæ
" Callorhynchidæ
" Chimæridæ

Subclass **ARTHROGNATHI** *Dean*[2] Inc. Sedis.
Order **Anarthrodira** *Dean*
Suborder **Stegothalami** *Dean*
Fam. Macropetalichthyidæ
" Asterosteidæ Inc. Sedis.
Order **Arthrodira** *A. S. Woodward*
Suborder **Temnothoraci** *Dean*
Fam. Chelonichthyidæ
Suborder **Arthrothoraci** *Dean*
Fam. Coccosteidæ
" Trachosteidæ
" Dinichthyidæ
" Mylostomidæ
" Selenosteidæ

Subclass **TELEOSTOMI** (*Bonaparte*) *Owen*
Infraclass DIPNEUSTI *Haeckel*
Order **Ctenodipterini** *Pander*
Fam. Uronemidæ
" Ctenodontidæ
Order **Sirenoidei** J. Müller
Fam. Ceratodontidæ
" Lepidosirenidæ
Infraclass CROSSOPTERYGII *Cope*

[1] See Garman in *Bull. Mus. Comp. Zool*, Vol. XLI, pp. 243–272; and Dean, "Chimaeroid Fishes and their Development," *Carnegie Inst.*, Washington, 1906.

[2] The classification is from Dean in *Mem. N. Y. Acad. Sci.* Vol. II, Part III, 1901, pp. 120–123.

Order **Haplisitia** *Cope*
Fam. Tarasiidæ
Order **Osteolepida** *Boulenger*
Suborder **Rhipidistia** *Cope*
Fam. Osteolepidæ
" Rhizodontidæ (=Megalichthyidæ)
" Holoptychidæ
Suborder **Actinistia** *Cope*
Fam. Cœlacanthidæ
Order **Cladistia** *Cope*
Fam. Polypteridæ
Infraclass Actinopteri *Cope*
Cohort Ganoidei (*J. Müller*) *Jordan and Evermann*
Superorder Acipenseroidei *Traquair*
Order **Heterocerci** *Zittel* (Lysopteri) *Cope*
Fam. Palæoniscidæ
" Platysomidæ
" Catopteridæ (Dictyopygidæ)
Order **Chondrostei** *J. Müller*
Suborder **Glaniostomi** *Cope*
Fam. Chondrosteidæ
" Acipenseridæ
Suborder **Selachostomi** *Cope*
Fam. Polyodontidæ
Superorder Lepidosteoidei *Bridge* (Holostei *J. Müller* in part)
Order **Protospondyli** (*A. S. Woodward*)
Suborder **Mesoganoidei** nom. nov.
Fam. Stylodontidæ (Semionotidæ)
" Lepidotidæ
" Macrosemiidæ
" Dapediidæ [1]
" Pholidophoridæ
Suborder **Pycnodonti** [2]
Fam. Pycnodontidæ
Suborder **Aspidorhynchi** nom. nov. (Aetheospondyli *Woodw.* in part)
Fam. Aspidorhynchidæ
Suborder **Ginglymodi** *Cope* (Aetheospondyli *Woodw.* in part)
Fam. Lepidosteidæ
Suborder **Halecomorphi** *Cope* (Amioidei *Lütken*)

[1] Placed near the Pholidophoridæ by Boulenger.

[2] Cf. Hay, *Bibliography and Catalogue of the Fossil Vertebræ of North America*, p. 372.

Fam. Eugnathidæ (Caturidæ)
" Pachycormidæ
" Amiidæ
" Oligopleuridæ

Cohort TELEOSTEI
Superorder MALACOPTEROIDEI nom. nov
Order **Isospondyli** *Cope*[1] (Malacopterygii (*Cuvier*) ***Boulenger*** in part)
Fam. Archæomænidæ
" Leptolepididæ
" Elopidæ
" Albulidæ
" Mormyridæ
" Hyodontidæ
" Notopteridæ
" Osteoglossidæ
" Pantodontidæ
" Ctenothrissidæ
" Phractolæmidæ
" Saurodontidæ (*Cope non Zittel*)
" Ichthyodectidæ *Crook*
" Clupeidæ[2]
Subfam. Thrissopatrinæ
" Engraulinæ
" Clupeinæ
" Chaninæ
Fam. Salmonidæ
" Alepocephalidæ
" Stomiatidæ[2]
Subfam. Chauliodontinæ
" Gonostomatinæ
" Sternoptychinæ
" Stomiatinæ[2]
Fam. Gonorhynchidæ
" Cromeriidæ
Order **Ostariophysi** *Sagemehl*
Suborder **Heterognathi** *Gill*
Fam. Characidæ[2]
Subfam. Erythrininæ
" Hydrocyoninæ
" Serrasalmoninæ
" Ichthyoborinæ

[1] Boulenger's division into families is followed.
[2] Boulenger's classification.

Subfam. Xiphostominæ
" Anostominæ
" Hemiodontinæ
" Distichodontinæ
" Citharininæ
Suborder **Glanencheli** *Cope* (Gymnonoti *Gill*)
Fam. Gymnotidæ
Suborder **Eventognathi** *Gill*
Fam. Cyprinidæ[1]
Subfam. Catostominæ
" Cyprininæ
" Cobiditinæ
" Homalopterinæ
Suborder **Nematognathi** *Gill*
Fam. Siluridæ[1]
Subfam. Clariinæ
" Silurinæ
" Bagrinæ
" Doradinæ
" Malopterurinæ
" Callichthyinæ
" Hyophthalminæ
" Trichomycterinæ
Fam. Loricariidæ[1]
Subfam. Arginæ
" Loricariinæ
Fam. Aspredinidæ[1]
Superorder UNCERTAIN
Order **Apodes** (*Linn.*) *Kaup*
Suborder **Archencheli** *Jordan*
Fam. Anguillavidæ
Suborder **Enchelycephali** *Cope*
Fam. Anguillidæ
" Nemichthyidæ
" Synaphobranchidæ
Suborder **Colocephali** *Cope*
Fam. Murænidæ
Suborder **Carencheli** *Gill*[2]
Fam. Derichthyidæ
Suborder **Lyomeri** *Gill and Ryder*[2]
Fam. Saccopharyngidæ

[1] Boulenger's classification.
[2] Incertæ Sedis may deserve a higher rank coördinate with Apodes.

Order Symbranchii *Gill*
  Suborder **Ichthyocephali** *Cope*
    Fam. Monopteridæ
  Suborder **Holostomi** *Cope*
    Fam. Symbranchidæ
Order Heteromi (*Gill*) *Boulenger* [1]
    Fam. Dercetidæ (Inc. Sedis)
      " Halosauridæ
      " Lipogenyidæ
      " Notacanthidæ
      " Fierasferidæ
Superorder MESICHTHYES (*Hay*) *mihi*
Order Haplomi *Gill*
  Superfamily Aulopoidea (*Gill*) (Iniomi *Gill*)
    Fam. Scopelidæ
      " Alepidosauridæ
      " Cetomimidæ
      " Chirothricidæ Inc. Sedis
      " Enchodontidæ
      " Kneriidæ Inc. Sedis
      " Cobitopsidæ Inc. Sedis
  Superfamily Esocoidea *Starks*
    Fam. Umbridæ
      " Esocidæ
  Superfamily Dalloidea *mihi* (Xenomi *Gill*)
    Fam. Dalliidæ
  Superfamily Pœciloidea *Starks*
    Fam. Pœciliidæ (Cyprinodontidæ)
  Superfamily Amblyopsoidea *Starks*
    Fam. Amblyopsidæ
  Superfamily Stephanoberycoidea *nom. nov.*
    Fam. Stephanoberycidæ [2]
  Superfamily Galaxoidea *nom. nov.* (Incertæ Sedis)
    Fam. Galaxiidæ [2]
      " Haplochitonidæ [2]
Order Salmopercæ *Jordan and Evermann* (Incertæ Sedis)
    Fam. Percopsidæ
Order Synentognathi *Gill*
    Fam. Belonidæ
      " Exocœtidæ
      " Protaulopsidæ (Inc. Sedis)

[1] According to Jordan the naturalness of this assemblage is open to question.

[2] Placed by Boulenger in this order.

Superorder THORACOSTRACI *Swinnerton* (Phthinnobranchii *Hay*)
Order **Hemibranchii** *Cope*[1]
Fam. Gasterosteidæ
" Aulorhynchidæ
" Aulostomidæ
" Fistulariidæ
" Macrorhamphosidæ
" Centriscidæ
" Amphisilidæ
Order **Lophobranchii**[2] *Cuvier*
Fam. Solenostomidæ
" Syngnathidæ
Superorder ACANTHOPTEROIDEI *nom. nov.*
Order **Percesoces** (*Cope*) *Gill*
Superfamily Sphyrænoidea *Starks*
Fam. Sphyrænidæ
Superfam. Atherinoidea *Starks*
Fam. Atherinidæ
" Chiasmodontidæ
Superfam. Mugiloidea *Starks*
Fam. Mugilidæ
Superfam. Polynemoidea *nom. nov.*
Fam. Polynemidæ[3]
Order **Anacanthini** *J. Muller* (?)
Fam. Macruridæ
" Gadidæ
Order **Labryinthici** *Jordan* (?) Inc. Sedis
Fam. Osphromenidæ
" Anabantidæ
" Ophiocephalidæ
Order **Acanthopterygii** (*Cuvier*)
Suborder **Berycoidei** *Jordan* (?)
Fam. Berycidæ
" Holocentridæ
" Monocentridæ
" Polymixidæ
Suborder **Zeoidei** *Jordan* (?)
Fam. Zeidæ
" Amphistiidæ

[1] Families as given by Boulenger.
[2] For the position of the Pegasidæ which are usually placed with this order see p. 505.
[3] Placed by Boulenger in this assemblage.

Suborder **Heterosomata** Bonaparte
Fam. Pleuronectidæ
Suborder **Percomorphi** *Cope*
Division Perciformes (*Günther*) *Boulenger*
Superfamily Percoidea[1] ———
Fam. Aphredoderidæ
" Elassomidæ
" Centrarchidæ
" Percidæ
" Apogonidæ
" Oxylabracidæ
" Acropomatidæ
" Serranidæ
Subfam. Serraninæ
" Grammistinæ
" Priacanthinæ
" Centropominæ
" Ambassinæ
" Pomatominæ
" Chilodipterinæ
" Lutjaninæ
" Cirrhitinæ
" Pentacerotinæ
Fam. Sillaginidæ
" Trichodontidæ
" Sciænidæ
" Gerridæ
" Pristipomatidæ (Hæmulidæ)
" Sparidæ
" Mullidæ
" Pseudochromidæ (Latilidæ)
" Cepolidæ
Superfamily Embiotocoidea *nom nov.* (Holconoti *Cope*)
Fam. Embiotocidæ
Superfamily Toxotoidea *Gill*
Fam. Toxotidæ
Superfamily Pomacentroidea *Gill* (Chromides)
Fam. Cichlidæ
" Pomacentridæ
Superfamily Labroidea *Gill* (Pharyngognathi *Cope?*)
Fam. Labridæ
" Scardiæ

[1] Only the principal families as given by Boulenger are listed.

Division Squamipinnes (*J. Müller*)
Fam. Scorpididæ
" Caproidæ (Antigoniidæ)
" Chætodontidæ
" Zanclidæ
" Acanthuridæ
" Teuthididæ
" Pygæidæ
" Siganidæ
Division Nomeiformes *nom. nov.*
Superfam. Tetragonuroidea (*Gill*)
Fam. Tetragonuridæ
" Stromateidæ
" Icosteidæ
Division Scombriformes[1] *Boulenger*
Fam. Carangidæ
" Rhachicentridæ
" Scombridæ
" Trichiuridæ
" Histiophoridæ
" Xiphiidæ
" Luvaridæ
" Coryphænidæ
" Bramidæ
Suborder **Kurtiformes** *Boulenger*
Fam. Kurtidæ
Suborder **Gobioidei** *Jordan and Evermann*
Fam. Gobiidæ
Suborder **Discocephali** *Jordan and Evermann?*
Fam. Echeneididæ
Suborder **Pareiopliteæ** Richardson (Scleroparei *Boulenger*)
Superfam. Scorpænoidea *Gill*
Fam. Scorpænidæ
" Hexagrammidæ
" Comephoridæ
Superfamily Rhamphocottoidea *Gill*
Fam. Rhamphocottidæ
Superfam. Cottoidea (*Gill*)
Fam. Cottidæ
" Cyclopteridæ
" Liparidæ
Superfam. Platycephaloidea *Gill*

[1] A grouping of the various Scombriform families into superfamilies has not yet been successfully attempted.

Fam. Platycephalidæ
" Hoplichthyidæ
Superfam. Agonoidea *Gill*
Fam. Agonidæ
Superfam. Trigloidea *Gill*
Fam. Triglidæ
" Dactylopteridæ
Suborder **Jugulares** (*Linn.*) *Boulenger*[1]
Superfam. Percophoidea *Gill*
Fam. Trachinidæ
" Percophiidæ
" Leptoscopidæ
" Nototheniidæ
" Uranoscopidæ
Superfam. Callionymoidea[1] *nom. nov.*
Fam. Trichonotidæ
" Callionymidæ
" Gobiesocidæ
Superfam. Blennoidea[1]——?
Fam. Bleniidæ
" Ptilichthyidæ
" Batrachidæ
" Pholididæ
" Zoarcidæ
" Congrogadidæ
" Ophidiidæ
" Podatelidæ
Order **Selenichthyes** *Boulenger* (Incertæ Sedis)
Fam. Lampridicæ
Order **Tæniosomi** *Jordan and Evermann* (Incertæ Sedis)
Fam. Trachypteridæ
Order **Plectognathi** *J. Muller*[2]
Suborder **Sclerodermi** (*Cuvier*)[1]
Fam. Triacanthidæ
" Triodontidæ
" Balistidæ
" Monacanthidæ
" Ostraciidæ
Suborder **Gymnodontes** (*Cuvier*)[1]
Fam. Tetrodontidæ
" Diodontidæ
" Molidæ

[1] Families as defined by Boulenger.
[2] A division of this order into superfamilies is desirable.

Order **Hypostomides** *Gill*[1]
 Fam. Pegasidæ
Order **Opisthomi** *Gill*
 Fam. Mastacambelidæ
Order **Pediculati** *Gill*[2]
 Fam. Lophiidæ
 " Ceratiidæ
 " Antenariidæ
 " Gigantactinidæ
 " Malthidæ

Infraclass CROSSOPTERYGII[3] *Cope.*

"These forms appear in the Upper Devonian, flower out in the late Palæozoic, and one group, the Cœlacanths, persists almost unchanged throughout the whole series of formations from the Lower Carboniferous to the Upper Chalk" (Woodward).

The superorder is sharply **distinguished from the Actinopteri** by the following assemblage of characters, (1) The **paired fins are lobate,**[4] **i.e., with a cartilaginous axis,** scaly externally and fringed on both sides by dermal rays. (2) The dorsal and anal fins are remarkably analogous to the paired fins in form and probably in function, and in the relations of the dermal rays to the endoskeletal supports; the median fins usually lack the numerous supporting fin fulcra so characteristic of the primitive Actinopteri. (The *Osteolepidæ* however exhibit modified enamelled anterior ridge scales which resemble the fulcra of higher forms.) (3) The axonosts of the dorsal and anal fins exhibit various degrees of coalescence, so that finally the paddle-like median fins probably enjoyed a high complexity and independence of movement. (4) There are two dorsal fins in the primitive forms. (5) The tail fin, in the earliest forms heterodiphycercal, often coalesces with the posterior dorsal and anal fins into the gephyrocercal form.[5] (6) A spiracle is present. (7) The distal end

[1] Incertæ Sedis, see page 505; may be only a division of the Acanthopterygii Pareioplitæ.

[2] Families as defined by Boulenger.

[3] (κροσσόι, tassels, a fringe, πτερύγιον, a little wing, fin, in allusion to the tassel-like pectoral fins, or to the fringe-like dorsals of *Polypterus*.)

[4] Except possibly the ventral fin of *Eusthenopteron* and its allies.

[5] See Appendix II.

of the hyomandibular has not yet segmented off to form a symplectic, although the jaw suspension is methyostylic.[1] (8) The mandible has usually several dentigerous splenials on its inner side. (9) The large gular plates are bordered by small anterior and numerous lateral gulars. (10) The scales are bony with a heavy coating of ganoine, and apparently represent clusters of shagreen-like denticles. (11) The ribs are both hypaxonic (hæmapophyses) and epaxonic (parapophyses).

There is much evidence that the Crossopterygii are nearly related to the Dipnoi and Amphibia (pp. 444). And in the other direction Dean calls them "osseous sharks," because: (1) The scales seem to indicate derivation from clusters of shagreen cusps. (2) *Polypterus* retains a spiracle, an optic chiasma, and shark-like viscera including a spiral valve and a conus arteriosus. (3) The lobate paired fins may be interpreted as having been derived from the non-lobate form seen in Sharks and in the pelvic fin of *Eusthenopteron*.

The Crossopterygii **parallel the Actinopteri** in (1) the replacement of cartilage by bone, both in the endo- and exoskeletons, (2) the aggregation and fusion of shagreen tubercles into scales and plates, (3) the development (in the Cœlacanths) of the swim-bladder as a hydrostatic organ and its ossification, as in certain catfishes, (4) the adaptive radiation of the body form from the primitive fusiform type into short-bodied and long-bodied types (even an eel-like form, *Calamoichthys*, being at last evolved), (5) the modification of the heterocercal tail into the diphycercal and gephyrocercal types, (6) the reduction in number of the dermal rays for closer correlation with the endoskeletal supports and the development of mobile fins supported by strong dermal rays, (7) the reduction and proximal withdrawal (especially in Cœlacanths) of the cartilaginous elements of the paired fins *pari passu* with the increase in size of the dermal fin rays. Nos. 4–7 enable the movements of the internal skeleton to be trans-

[1] I. e. with the metapterygoid and opercular bones assisting the hyo mandibular in the support or bracing of the quadrate or mandible. See Gregory, "The Relations of the Anterior Visceral Arches to the Chondrocranium," *Biological Bulletin*, Vol. VII, No. 1, June, 1904, pp. 55–69.

mitted without loss of power to the dermal fins. In general among vertebrates, *as specialization for easy swimming progresses, the sources of movement become more deeply seated, and the extent and mobility of the freely flapping membrane increase.* This law is illustrated among fishes, marine reptiles, and aquatic mammals.

Boulenger, followed by Bridge,[1] includes the Rhipidistia and Actinistia under the "suborder" Osteolepida (here taken as an order), with the following definition:

"The obtusely or acutely lobate pectoral fins articulate with the pectoral girdle by a single basal endoskeletal element. Nostrils on the ventral surface of the snout. Two dorsal fins and an anal fin. Dermal bones of the ethmoid region often fused with one another and with the premaxillæ in front and the frontals behind to form a continuous rostral shield. Infra-dentary bones may be present. A series of lateral jugular plates often present in addition to the pair of principal plates."

In contrast with this the surviving order Cladistia (including only the Polypteridæ) is thus defined.

"Pectoral fins uniserial and abbreviate, with three basal endoskeletal elements. Nostrils on the upper surface of the snout. Entire skeleton well ossified. Notochord replaced by bony amphicœlous vertebral centra. Bones of the ethmoid region not fused to form a rostral shield. Infra-deutary bones absent. Juglar plates reduced to a single pair of large plates."

The following analysis of the ordinal characters of the Crossopterygii was drawn up by Prof. H. F. Osborn and Dr. J. H. McGregor after Cope and Smith Woodward.

[1] *Cambridge Nat. Hist.* Vol. Fishes, etc., pp. 477, 481.

SUPERORDER *CROSSOPTERYGII*

ORDER:	*Haplistia* (Cope)	*Rhipidistia* (Cope)			*Actinistia* (Cope)	*Cladistia* (Cope)
FAMILY:	Tarrasiidæ	Holoptychidæ (Traquair)	Rhizodontidæ (Traquair)	Osteolepidæ (A. S. Woodward)	Cœlacanthidæ (Huxley)	Polypteridæ (Huxley)
Median fins:	One continuous median fin, regular series of *basals* and *radials*, more numerous than opposed arches of axial skeleton. Dermal rays much more numerous.	Median fin represented by two dorsals, one ventral, and a caudal. In the posterior dorsal and the ventral the basals of each fin are coalesced, forming a single piece. Radials less numerous than the opposed dermal rays.			Posterior dorsal and anal with forked basipterygium. Tail gephyro-diphycercal. Caudal radials agree in number with contiguous vertebral arches and dermal fin rays.	Dorsal broken up into finlets. Tail gephyrocercal. Basoradials equal in number the corresponding dermal rays.
Pectoral fins:	Obtusely lobate	Acutely, lobate (long), fringed on both sides with dermal rays	Short, obtusely lobate	Short, obtusely lobate	Short, obtusely lobate	Short, obtusely lobate. Three basals.
Pelvic fins:	Unknown	More obtuse than pectoral	Short, obtusely lobate	Short, obtusely lobate	Short, obtusely lobate	Lobe greatly reduced.
Notochord and Vertebræ:	Persistent ?	Unconstricted No ossified vertebræ	Ring-vertebræ ossified	Ring vertebræ ossified	Unconstricted No ossified vertebræ	Largely replaced by ossified amphicœlous vertebræ. Both epaxonic (pleurapophyses) and hypaxonic ribs (hæmapophyses) present.
Scales: *Teeth:*	Rhomboid	Cycloid Greatly folded Numerous	Cycloid Folded at base Few	Rhombic Folded slightly at base. Few	Cycloid	Rhombic. Conical. Simple pulp cavity.
	Tarrasius	*Holoptychius*	*Rhizodus* *Strepsodus* *Rhizodopsis* *Eusthenopteron*	*Osteolepis* *Thursius* *Diplopterus* *Megalichthys*	*Cœlacanthus* *Undina* *Macropoma*	*Polypterus*. *Calamoichthys*.
	Low. Carboniferus	Devonian	Devon. Carbon	Devon. Carbon. Lo Permian	U. Devon (?) to U. Cretac	Recent.

Infraclass ACTINOPTERI[1] *Cope.*

This infraclass includes all the remaining 'Ganoidei' and 'Teleostei,' the vast majority of living fishes. In fossil forms these ray-finned types are readily distinguished from the lobe-finned Crossopterygii or the Dipnoi.

Principal Characters. (Compare Crossopterygii, p. 456). (1) The paired fins are non-lobate, i.e., the endoskeletal parts (basals or "axonosts" and radials or "baseosts") are greatly reduced, so that the blade or free portion of the fin is formed entirely of dermal rays. (2) The median fins are unlike the paired fins; they exhibit dermal rays which articulate proximally with baseosts and these in turn with axonosts, which primarily correspond in number with the neural and hæmal spines; the median fins are primitively bordered anteriorly by large fin fulcra (lost in later and progressive forms). These fulcra or ridge-scales are "medium, spine-like or Λ-shaped scales" (Bridge). (3) In the most primitive forms there is only one dorsal fin, which may give rise in the higher forms to two or more. (4) The caudal fin is primitively heterocercal, but in later forms is modified into the homocercal, diphycercal, and gephyrocercal types. (See Appendix II.) (5) The spiracles are reduced or obliterated. (6) The distal end of the hyomandibular gives origin to the symplectic (sometimes absent). (7) The jaw suspension is methyostylic[2] and the mandible progressively simplifies by the reduction of splenials and surangulars. (8) The gular plates are progressively reduced; concomitantly the branchiostegals become more and more important. (9) The scaly exoskeleton (sometimes reduced) consists either of (*a*) rhombic bony scales covered with ganoine and articulating one with the other, or (*b*) of cycloid or ctenoid scales with little or no ganoine, the bony tissue lacking the Haversian canals, or (*c*) of bony scutes and plates. (10) The ribs are hypaxonic (hæmapophyses) only. (11) Except in sturgeons, etc., the chondroskeleton largely ossifies, and the notochord is more or less superseded by enveloping vertebræ.

[1] (ἀκτίς, ray, πτερόν, wing, fin.)

[2] See footnote [1] page 457.

The infraclass Actinopteri exhibits an amazing variety of forms grading from the shark-like cartilaginous Sturgeons and Paddle-fishes to the most specialized bony fishes. Two more or less continuous major groups or series are recognized, a more generalized ancient series the Ganoidei (term used in the sense explained on p. 444), and a more specialized modern series the Teleostei. Because morphologically annectant forms are numerous, it is difficult to draw a hard and fast taxonomic line between the two groups.

Morphological Transition from Lower to Higher Types.[1] In the more generalized fossil Ganoids (Acipenseroidei): (1) the notochord is persistent (though strengthened by neural and hæmal arches), (2) intermuscular or epipleural bones are absent, (3) infraclavicular plates are retained, (4) the scales are rhombic, bony, with a heavy ganoine lacquer, often with a peg-and-socket articulation, (5) the dermal fin rays are much more numerous than their endoskeletal supports, (6) large fulcra strengthen the median fins anteriorly, (7) the tail is strongly heterocercal (save in Belonorhynchidæ), (8) baseosts (radials) persist in both pectoral and pelvic fins. But the higher or Holostean Ganoids (e. g. *Caturus*, *Leptolepis*, see page 464) approximate more and more to the Teleosts. Usually (1) the notochord is surrounded or replaced by ring-like ossifications (pleuro- and hypocentra) which finally (e. g. in Oligopleuridæ) become perfect vertebræ; (2) the scales, losing the peg-and-socket articulation, most of the ganoine, and the Haversian canals in the bone, become rounded to cycloidal, and deeply overlap; (3) the infraclavicles are reduced or wanting, functionally replaced by the cleithra, or "clavicles"; (4) intermuscular (epipleural and epineural) bones appear, giving the muscles better control of the backbone, while the development of a bony supraoccipital gives the body muscles a better hold upon the head; (5) the fins gradually lose the fulcra and the dermal rays and become closely correlated by reduction with their endoskeletal supports; (6) in the tail fin an upturning and abbreviation of the caudal axis causes an approach toward true homocercy (Appendix II); (7) baseosts disappear from the pelvic and are reduced in the pectoral fins;

[1] See Plate XXX.

(8) gular plates slowly give way to branchiostegals as the head becomes narrower; (9) the splenials disappear from the mandible; (10) the hinder expansion of the maxillary gives rise to a separate supramaxillary; (11) the preoperculum withdraws from the cheek and comes into closer relationship with the pterygopalatine series, assisting in the support of the quadrate (note 1, p. 457); (12) the chondrocranium is now much reduced, and replaced by cartilage bones.

Cohort Ganoidei (*J. Muller, Jordan, and Evermann*)

Superorder Acipenseroidei *Traquair*

(Palte XXIX)

Notochord persistent, with neural and hæmal arches. Teeth small or wanting. Infraclavicles present. Paired fins actinopterous with a row of baseosts. A single dorsal and anal fin, with dermal rays more numerous than their supports; caudal fin (at least) with fulcra. Caudal fin heterocercal, the upper lobe usually scaly. Chondrocranium apparently but little ossified, the cranial bones mainly dermal.

Order **Heterocerci** *Zittel*

Notochord persistent, but arches, spinous processes, and fin supports more or less ossified; opercular apparatus well developed; branchiostegal rays numerous. Unpaired, and usually also paired fins fringed with fulcra. Scales rhombic or rhomboidal, rarely cycloidal.

Palæoniscidæ	Devonian to Upper Jurassic
Platysomidæ	Carboniferous and Permian
Dictyopygidæ (Catopteridæ) Incertæ Sedis	Trias

Order **Chondrostei** *J. Muller* 1846.

Endoskeleton chiefly cartilaginous. Opercular apparatus imperfectly developed, the branchiostegal rays usually absent. Trunk almost or completely naked or with rows of bony plates.

Chondrosteidæ	Lias (Lower Jura)
Acipenseridæ	Tertiary and Recent
Polyodontidæ	Cretaceous (?) Eocene to Recent
Belonorhynchidæ Incertæ Sedis	Trias and Lias (Lower Jura)

The earliest known Actinopteran, *Cheirolepis*, of the Lower Old Red Sandstone and Upper Devonian, forerunner of the Palæoniscidæ, can be readily distinguished from the contemporary and numerous Crossopterygians by its non-lobate paired fins, the archaic form of its heterocercal tail, its lack of paired central gular plates, and the corresponding development of lateral branchiostegal rays, and by its minute rhomboidal, obliquely arranged scales (almost suggesting those of Acanthodian Elasmobranchs). This generalized type may be traced on the one hand into the deep-bodied Platysomidæ of the Carboniferous and Permian, and, on the other hand, through the Chondrosteidæ, into the long-bodied and more or less scaleless and degenerate Sturgeons (Chondrostei). Possibly on account of the restriction imposed by the simple rhombic type of squamation upon lateral flexures of the body in swimming, we observe: (1) the occurrence of deeply overlapping and even cycloid scales (*Coccolepis* of the Palæoniscidæ), and (2) the partial or complete suppression of the scales in *Phanerosteon* of the Palæoniscidæ, *Dorypterus* of the Platysomidæ, and in the entire suborder Chondrostei. It is noteworthy that the early Heterocerci, commonly grouped together in the family Palæoniscidæ, include forms (e. g. *Cheirolepis*, *Holurus*, *Coccolepis*) which are so different in several important respects that they might almost be regarded as the types of distinct families.

The Catopteridæ present a morphological advance in the direction of the Holostei, since they combine a Palæoniscid type of head with an externally homocercal tail.

Dorypterus of the Upper Permian of Germany, regarded by Smith Woodward as a specialized offshoot from the Platysomidæ, is deep-bodied and *Stromatæus*-like, and suggests *Lampris* in its general body form and its many-rayed ventrals (Jordan, '05).

The Belonorhynchidæ may be either very aberrant Chondrostei or "abnormally modified Crossopterygians."[1] There is no trace of heterocercy in the tail (cf. the tail of *Eusthe-*

[1] Reis, O. M., "Zur Osteologie und Systematik der Belonorhynchiden und Tetragonolepiden," *Geogr. Jahresh.*, 1891 (1892), p. 157

A. S. Woodward, *Cat. Foss. Fishes*, Brit. Mus., Part III, 1895, pp. vii, Pl. 23.

nopteron among Crossopterygians); the large conical teeth are separated by intervening minute teeth (cf. Rhizodontidæ among Crossopterygii but also *Cheirolepis* among Heterocerci); the opercular series is incomplete; the paired fins apparently exhibit a very feeble lobation (A. S. Woodward); fin fulcra are minute or absent; the sclerotic ring was probably ossified (cf. *Undina* among Crossopterygians).

Superorder LEPIDOSTEOIDEI *Bridge.*

(HOLOSTEI *J. Müller* in part.)
(Plate XXIX.)

The superorder includes those Actinopterous Ganoids which are Lepidosteoid in the larger sense; it may have been derived from some such forms as the Catopteridæ (page 463) among the Acipenseroidei, and indeed its oldest and most generalized representative, *Acentrophorus* of the Upper Permian, was long mistakenly referred to the Palæoniscidæ. But the group has progressed beyond the Chondrostei in the following assemblage of characters:

Notochord and vertebræ varying inversely in development, the vertebræ ranging from incomplete pleuro- and hypocentral rings to complete centra. Teeth well developed. Chondrocranium more or less completely replaced by cartilage bones corresponding to those generally present in Teleosts, "while the palato-pterygoid cartilages, likewise modified by the growth of cartilage bones, separately articulate with the lateral ethmoid regions instead of meeting in a ventral symphysis beneath the basis cranii" (Bridge). A supramaxillary (derived from the hinder portion of the maxillary). The preoperculum no longer extending over the cheek but coming into intimate relation with the pterygoquadrate series and assisting in the support of the mandible (see p. 462). Opercular apparatus usually complete, with branchiostegal rays and often a gular plate; a bony supraoccipital in the higher types; baseosts in paired fins reduced, in pelvic fins lacking. The dermal rays in all fins extensively developed, equal in number to the endoskeletal supports. Infraclavicles replaced by cleithra (clavicles) meeting in a ventral symphysis. Fulcra on median and paired fins present, or reduced in later

forms; tail hemiheterocercal (to homocercal). Scales rhombic or rhomboidal, generally arranged in oblique series, frequently united above and below by peg-and-socket articulations, and grading into very thin rounded or cycloidal scales, which greatly overlap. The mandible retains splenial and coronoid elements.

The principal divisions of the superorder Lepidosteoidei may be broadly sketched as follows:

Suborder 1. **Mesoganoidei** nom. nov.

1. Trunk more or less fusiform. Mouth small, teeth either styliform (Stylinodontidæ, Macrosemiidæ), conical (Pholidophoridæ), or tritoral (Lepidotidæ).

Stylinodontidæ, examples: *Acentrophorus*, Trias, *Up. Perm.*; *Semionotus (Ischypterus)* Upper Permian to Upper Jurassic.
Lepidotidæ, examples: *Colobodus*, *Lepidotus*, Trias to Cretaceous.

2. Trunk more elongate, mouth larger, marginal teeth styliform.

Macrosemiidæ, examples: *Macrosemius*, *Ophiopsis*, *Notagogus*, Trias to Cretaceous.

3. Retaining rhombic ganoid scales, but approximating in other characters toward the more generalized Isospondyles.

Pholidophoridæ, examples: *Pholidophorus*, *Phioldopleurus*, Trias-Jura.
Dapediidæ, examples: *Dapedius* (placed near the Pholidophoridæ by Boulenger).

Suborder 2. **Pycnodonti** *Hay ex Agassiz*

Trunk deeply fusiform or cycloidal. Teeth, prehensile on premaxillary and dentary, tritoral on vomer and splenial, forming a highly specialized crushing apparatus. Systematic position uncertain but apparently an offshoot of the *Lepidotus*-like genera (Woodward, '98, p. 101).

Pycnodontidæ, examples: *Pycnodus*, *Gyrodus*, *Microdon*, *Anomœdus*, Lower Jurassic to Lower Eocene.

Suborder 3. **Aspidorhynchi** nom. nov.

(Aetheospondyli *Woodward* in part.)

Swordfish-like Lepidosteoids, ordinally united by Woodward with the Lepidosteidæ, but differing from them in the possession of a predentary or premandibular bone and in the more normal character of the vertebræ.

Suborder 4. **Ginglymodi** *Cope.*

With opisthocœlus vertebræ.

Lepidosteidæ, *Lepidosteus*, Up. Cretaceous to Recent.

Suborder 5. **Halecomorphi** *Cope.*

(Amioidei *Lütken.*)

Trunk elongate; mouth large; predaceous, with piercing teeth. Exhibiting a progressive advance in the direction of the Isospondyli.

1. Eugnathidæ. Vertebræ absent or incomplete. Examples: *Eugnathus*, *Caturus*, Trias to Cretaceous.
2. Pachycormidæ. Swordfish-like Amioids. Vertebral axis without segmental vertebræ. Upper Lias (Lower Jurassic) to Upper Cretaceous.
3. Amiidæ. Vertebræ complete. Pleuro- and hypocentra in caudal region. Upper Jurassic to Recent.
4. Oligopleuridæ. Vertebræ well ossified, with no distinct pleuro- and hypocentra. Scales very thin and cycloid. Upper Jurassic to Upper Cretaceous. This family may deserve a higher taxonomic rank (Dean).

Cohort TELEOSTEI[1] *Owen.*

The difficulty of separating the lower Teleosts from the higher Ganoids has been commented upon above (page 461).

Although no *phylogenetic* series of genera has been definitely traced, connecting the Lepidosteoidei (Holostei) and the Malacopteroidei, it is easy to arrange a morphological series[2] leading back into some such Triassic Ganoids as the Pholidophoridæ. These show rhombic ganoid scales, small fin-fulcra, ring-like centra, and no intermuscular bones (i. e. ganoidean characters), combined with a carp-like form, homocercal tail, and no gular plates. The Leptolepididæ furnish the desired transition to the Isospondyli; since they reduce the ganoine and fin fulcra, develop a few intermuscular bones, and perfect the centra, changing the rhombic into cycloid scales. In the early Cretaceous Clupeoids the skeleton is so closely similar to that of the typical Jurassic Leptolepididæ that Smith Woodward[3] believes that the Clupeoids "may well be direct descendants" of the Leptolepididæ.

[1] τέλεος, perfect, ὀστέον, bone.

[2] See Plate XXX.

[3] *Cat. Foss. Fishes, Brit. Mus.*, Part IV, 1901, p. vii.

Superorder MALACOPTEROIDEI nom nov.[1]

PHYSOSTOMI[2] (*J. Muller* in part.)
(ISOSPONDYLI + OSTARIOPHYSI.)

(Plate XXIX.)

The connection between the Ostariophysi or Characin-Carp-Catfish series and the Isospondyli or typical soft-rayed fishes (e. g. Clupeidæ, Salmonidæ, Osteoglossidæ) is indicated by the following characters in common:

(1) The air bladder if well developed communicates with the digestive tract by a duct. (2) The mesocoracoid arch is present. (3) The orbitosphenoid is present. (4) The pelvic fins if present are abdominal. (5) The fin rays (except the single pectoral and dorsal spines of Catfishes) are soft or articulated. (6) The presence of an adipose dorsal fin in many Heterognathi (Characins) and Nematognathi (Siluroids) as in the Salmon-like fishes. However all these common characters may have been inherited from different ancestral families of the Mesoganoidei (p. 465). Boulenger restricts the term Malacopterygii of Artedi and of Cuvier to practically the same content as the term Isospondyli of Cope, the two divisions, Malacopterygii and Ostariophysi, being given coördinate rank as suborders of the order Teleostei. For the reasons given it seems better to use a new term, Malacopteroidei, in a broad or superordinal sense to include the two orders Isospondyli Cope and Ostariophysi Sagemehl.

Order **Isospondyli**[3] *Cope*

The name Isospondyli refers to the fact that, in contrast with the Ostariophysi (see page 472), the anterior vertebræ are not coalesced, nor are their processes modified into Weberian auditory ossicles. The vertebral centra are calcified, without separate pleuro- and hypocentra, but sometimes (in the Leptolepididæ) slightly perforated by the notochord. The broad maxillary forms part of the margin of the upper jaw, in the more primitive

[1] *μαλακός*, soft, *πτερὸν*, fin.

[2] *φῦσος*, bladder, *στόμα*, mouth, in allusion to the duct from the swim bladder into the œsophagus.

[3] *ἴσος*, equal, *σπονδύλος*, vertebra.

forms articulating independently of the premaxillary with the ethmoid (contrast the Ostariophysi). A symplectic is usually present[1]; the opercular bones are complete[2] (contrast the Ostariophysi); the pharyngeal bones are simple, above and below; the bony supraoccipital, in many forms still separated by the parietals from the frontals, progressively gains contact with the frontals (see page 471). As in Ostariophysi and actinopterous Ganoids, the precoracoid (mesocoracoid) arch is retained and the pectoral arch is suspended from the skull by a bony post-temporal. The simple air bladder (usually present) has a pneumatic duct leading into the digestive tract. The dermal rays of the median fins articulate with an equal number of endoskeletal supports. The dorsal and anal fins are spineless,[3] i. e. the fin rays are articulated, the pectorals (when present) are abdominal. Intermuscular bones are present. The caudal hæmapophyses and neurapophyses progressively expand and fuse into hypural and epural bones, the caudal portion of the vertebral column degenerating and becoming upturned, the tail finally becoming completely homocercal. Ganoidean characters, such as intergulars, interclavicles, fin fulcra, ganoine, splenials, coronoids, the intestinal spiral valve, and the multivalvular bulbus arterious, are all greatly reduced or absent.

The ordinal characters of this group are all generalized as compared with those of other Teleosts, which is equivalent to saying that the order is a central one related to the ancestors of the Mesichthyes and Acanthopteroidei. The generalized Leptolepididæ from the Jurassic and Cretaceous have already been noticed.

The **Elopidæ** are the most generalized of living Teleosts, with numerous representatives in the Cretaceous (e.g. *Spaniodon*), and with two surviving genera, *Elops* and the Tarpon (*Megalops*), both of which retain the Ganoidean gular plates. A progressive character is the forward and upward growth of the supraoccipital, which attains such importance in higher orders,

[1] Except in Mormyridæ, Phractolæmidæ, Cromeriidæ.

[2] Except in Pantodontidæ.

[3] Compare, however, the non-articulated rays in the dorsal fin of the Ctenothrissidæ.

but the supraoccipital has not yet displaced the parietals in the median line.

"The **Albulidæ** are merely Elopine fishes with a forwardly inclined mandibular suspensorium, a small mouth, and reduced branchiostegal apparatus. Their primitive character is, indeed, shown by the presence of a muscular conus arteriosus with two rows of valves in the heart of the sole surviving species.[1] They seem to differ from the Elopidæ in exactly the same manner as the more generalized Pycnodontidæ differ from the Semionotidæ among Jurassic fishes. Now, however, the splenial bone has disappeared, and is no longer available to bear a powerful dentition. A new modification, therefore, occurs for the first time, and is almost constantly repeated in later fishes which have teeth on the palate or the base of the skull. This upper dentition is henceforth usually opposed not to the mandible but to a dental arrangement on the tongue or hyoid apparatus" (A. S. Woodward[2]). Among the Cretaceous Albulids, *Istieus* is ancestral to the existing genus *Bathythrissa*, a long-bodied, deep-sea form. The existing members of the Elopidæ and Albulidæ undergo a developmental metamorphosis, the ribbon-shaped larvæ frequently being abyssal, like the larvæ of Eels. In both families the large maxillary is movably articulated above the premaxillary to the ethmoid (Boulenger), and the jaws, oral cavity, and throat are thickly studded with teeth.

The **Osteoglossidæ** are more specialized than the preceding families in the union of the larger maxillaries with the premaxillaries. The teeth, on the jaws, pterygoid and hyoid bones are thickly clustered. The four existing genera parallel the three existing genera of Dipnoi in habit and especially in distribution. This probably indicates that the Osteoglossidæ existed in the Jurrasic, side by side with the widely dispersed Dipnoi, the ranges of the groups being subsequently restricted *pari passu*. The head is scaleless, protected by thick derm bones; the large bony scales are composed of mosaic-like pieces. The huge *Ar-*

[1] "J. E. V. Boas, 'Ueber den Conus arteriosus bei *Butirinus* und bei anderen Knochenfischen,' *Morphol. Jahrb.*, Vol. VI, 1880, p. 528."

[2] *Catalogue of the Fossil Fishes in the British Museum*, Pt. IV, 1901, pp. vi, vii.

apaima gigas of Brazil, sometimes weighing 400 pounds, is more or less anguilliform (Appendix I). *Osteoglossum* also presents some approach toward the gephyrocercy of the tail fin (Appendix II). More generalized short-bodied genera (*Dapedoglossus*, *Brachyætus*) are known from the Eocene. The peculiar Pantodontidæ of West Africa, also short-bodied fishes, are essentially Osteoglossid flying-fishes with the pectoral fins greatly enlarged and the ventrals far forward as in the Ctenothrissidæ. A still more aberrant member of the Malacopterygii, apparently related to the Osteoglossidæ, is the unique *Phractolæmus ansorgii*, which might almost be placed in a separate suborder coordinate with the Scyphophori. The mouth is edentulous, projectile, proboscidiform; the supraoccipital is in contact with the frontals; the enormous interoperculars overlap below in the median line.

The **Mormyridæ** of the fresh waters of Africa north of the tropic of Capricorn have a funnel-like cavity in the pterotic region, closed by a lid-like supratemporal, possibly functioning like a Weberian auditory apparatus since the air bladder communicates with the ear. Cope founded the order Scyphophori chiefly upon this character, which is largely realized also in the **Hyodontidæ** or Moon-Eyes of North America. Boulenger believes this group to be related to the Albulidæ. The brain is comparatively enormous. The **Gymnarchidæ** are eel-like Mormyrids, and like them have a feebly developed electric organ on either side of the tail. The long dorsal fin enables them to swim backward or forward equally well. The West African and oriental **Notopteridæ** (Feather-backs), which Boulenger regards as "an eccentric modification of a type very similar to the Hyodontidæ," are of a peculiar rhomboidal shape, with very long anal fin (hypocercal type, Appendix II), which characters (here possibly correlated with marsh-living, partly terrestrial habits) are realized to a slight extent in *Dorasoma* (the Gizzard Shad) and more strongly in *Coila* among the Herrings.

"The primitive nature of the **Chirocentridæ**" (Saurodontidæ), says Smith Woodward,[1] "has long been inferred from the presence of a rudimentary spiral valve in the intestine of the sole surviving species, *Chirocentrus dorab*. This family

[1] Cat. Foss. Fishes Brit. Mus., Part IV, 1901, p. vii.

of fishes is, indeed, now proved to be very old, dating back at least to the beginning of the Cretaceous period, during which it attained its maximum development." The Cretaceous genus *Portheus* attained gigantic size (4.7 m.). Like so many other relics of Cretaceous fish faunas, the nearest living representative of this family (*Chirocentrus*) is found in the Indian Ocean and the seas of China and Japan.

The true **Clupeoid** fishes (Herrings, Anchovies, etc.) lead back through the genus *Thrissopater* of the Middle Cretaceous to the Elopidæ. The Anchovies (Engraulinæ) may be derived from *Spaniodon* of the Upper Cretaceous, the Milk-fishes (Chaninæ) from *Prochanos* of the Cretaceous, the Clupeinæ from *Pseudoberyx* and several other genera from the Upper Cretaceous. Certain Cretaceous Clupeoids, namely, the Ctenothrissidæ, were formerly allocated with the spiny-finned Berycidæ (see p. 501), on account of the forward displacement of the pelvic fins, and of the spiny or non-articulated character of the four anterior rays of the dorsal; but Boulenger points out that in the small premaxillaries and enlarged maxillaries they agree with the Malacopterygii, whilst in the forward position of the ventrals they are "most nearly approached by the Pantodontidæ" (Boulenger).

The **Salmonidæ** and their allies differ from the Clupeidæ chiefly in (1) the presence of a small adipose fin, (2) in the contact between the supraoccipital and the frontals, and (3) in the vestigial condition of the oviducts, the ova (as in the Osteoglossidæ, Hyodontidæ) falling into the cavity of the abdomen before exclusion (Boulenger); but their exact relationships are not known. They are believed by Boulenger to be of "comparatively recent age, no remains older than Miocene . . . being certainly referable to this family."

The **Alepocephalidæ,** deep-sea Clupeoids, lacking an adipose dorsal, and with the rayed fin very far back.

The **Stomiatidæ,** aberrant deep-sea forms paralleling the Scopeloids, but with the maxillary instead of the premaxillary greatly enlarged, the pectoral fins often disappearing, while the pelvic fins are large. Extremely variable in body form, including long, eel-like forms, and short, Beryx-like forms.

The **Gonorhynchidæ** are believed by A. S. Woodward

to be nearly related to the Scopelidæ (p. 487), but are assigned to the Isospondyli by Boulenger. They are represented in the Upper Cretaceous of Europe and in the freshwater Eocene beds of France and North America. The sole existing species is known from the seas off Japan, South Africa, Australia, and New Zealand. They are somewhat pike-like in form, with sturgeon-like mouth and snout; they have scaly fins, peculiar ctenoid scales of an advanced type, and a long 'accessory scale' on the paired fins, like certain other members of this assemblage. Resembling the Gonorhynchidæ is the tiny fish *Cromeria*, recently discovered in the White Nile, for which a new family has been erected.

Superorder MALACOPTEROIDEI (*cont'd*).
(Plate XXIX.)

Order **Ostariophysi**[1] *Sagemehl* 1885.

(Plectospondyli Cope + Glanencheli Cope + Nematognathi Gill.)

In this principally fresh-water group, which comprises the Catfishes, Carps, Characins and Gymnotids, the anterior four vertebræ are greatly modified, often coössified, their ribs and neural and hæmal elements forming a chain of bones connecting the air bladder with the auditory organ. The importance of these bones in classification was indicated by Cope in his diagnosis of the orders Plectospondyli Cope (Carps and Characins), Glanencheli Cope (Gymnotids), and Nematognathi Gill (Catfishes). These ossicles have been shown by Sagemehl to be severally homologous and to have the same relations with the spinal nerves, throughout the order, which is hence regarded by Boulenger as "one of the most natural groups of the class Pisces." Points of agreement with the Isospondyli are: (1) the air bladder, if well developed, communicates with the digestive tract by a duct; (2) the pectoral arch is suspended from the skull; (3) the mesocoracoid (precoracoid) arch is present; (4) the pelvic fins if present are abdominal; (5) the fin rays are soft and articulated, except the pectoral and the dorsal spines of catfishes,

[1] ὀστάριον, a little bone, φῦσος, bladder, in allusion to the Weberian auditory ossicles.

each of which results from the coössification of the segments of a single articulated ray.

Four suborders are here recognized: (1) Heterognathi Gill (Characins), (2) Glanencheli Cope (Gymnonoti Gill, Gymnotids), (3) Eventognathi Gill (Carps), (4) Nematognathi Gill (Catfishes). These exhibit many divergences of form and structure, upon which several orders have hitherto been based. On the other hand, their common origin seems so well assured that Smith Woodward and Boulenger, in adopting Sagemehl's group "Ostariophyseæ," unite them into a single order, without major divisions; but it here seems preferable to recognize the suborders named above.

The Characins are undoubtedly the most generalized and are regarded by Boulenger as representing the ancestral stock, which gave off (1) the Gymnotids as a specialized eel-like side branch, and (2) an undiscovered annectant form leading to both Catfishes and Carps. The group is almost exclusively non-marine.

Order **Ostariophysi** (*cont'd*).

Suborder **Heterognathi**[1] *Gill*

The Characins.

The **subordinal characters** of this group, as compared with those of the Carps and Catfishes, are nearly all primitive. Thus barbels are lacking, the head is naked, the body covered with cycloid scales, both premaxillaries and maxillaries form the margin of the upper jaw,[2] the premaxillaries are not protrusile, the jaws usually toothed; the upper pharyngeal bones are often as many as four; lower pharyngeals are normal, armed with small, sometimes villiform teeth; the osseous brain-case is not produced between the orbits, an adipose dorsal is often present, the air bladder is transversely divided into two portions; and (in contrast with the Catfishes) the maxillaries are well developed, the fin

[1] ἕτερος, different, γνάθος, jaw, in allusion to the various modifications of the jaws and teeth.

[2] Save in *Ichthyoborus* and *Neoborus*, which parallel the Nematognathi in the reduction of the maxillary and its exclusion from the oral gape (Boulenger).

rays all soft, the body scaly, the parietals not fused with the supraoccipitals.

None of their independent specializations is of subordinal value, but in the typical Characins (1) the skull is "more or less invaded by reëntering valleys from behind," (2) the supraoccipital is "partly superior and carinated by a procurrent crest" (Gill), (3) the ribs are mostly sessile, all the greater number of the precaudal vertebrae being without parapophyses (Boulenger.)

The Characins, although clearly allied to the other Ostariophysi, show many analogies in appearance with the Salmonidæ among Isospondyles. They present a great range of genera and species characteristic of the fresh waters of tropical America and Africa south of the Sahara. In Africa they accompany their remote relatives the Carps, but in tropical America they entirely replace them. Many are extremely predaceous, others are exclusively vegetable feeders; the dentition is equally diversified.[1]

A peculiar group, the Gymnotidæ, or Characin Eels, was given ordinal rank (Gymnonoti) by Cope, Gill, and others, but Reinhardt has proved that they are simply a highly specialized offshoot from the Characins, from which they differ chiefly in the eel-like body, obsolete dorsal and pectoral fins, and forward shifting of the anus to a point near the throat. They exhibit close analogies (due to living in turgid rivers) to the eel-like Mormyrs of Africa (Appendix I). The famous Electric Eel (*Gymnotus electricus*) also parallels the Mormyrid *Gymnarchus* and the Electric Catfish (*Malapterurus*) in the possession of an electric organ on either side of the tail.

COMPARISON OF THE CHIEF DIAGNOSTIC CHARACTERS OF THE SUBORDERS OF OSTARIOPHYSI.

(*Compiled from Jordan and Evermann, Eigenmann, Boulenger.*)

	HETEROGNATHI (Characins)	EVENTOGNATHI (Carps)	NEMATOGNATHI (Catfishes)
Body	Scaly.	Scaly or naked.	Naked or armed with bony plates.
Head	Naked	Naked	Naked or armed with bony plates.
Barbels	None	Present or absent	Present.
Mouth	Not protractile.	More or less protractile	Not protractile.

[1] See Eigenmann, C. H., in *Biol. Bull.*, Vol. VIII, Jan, 1905 p. 61.

	(Characins)	(Carps)	(Catfishes)
Margin of upper jaw	Formed by premax. and max.	Formed by premax. or by premax. and max.	Formed by pmx. alone; mx. much reduced.
Teeth on jaws	Often present	Absent	Absent or limited to pmx.
Upper pharyngeals	1–4	2	? Normal.
Lower pharyngeals	Normal, toothless.	Falciform, toothed.	Normal.
Opercular apparatus	Normal, complete.	Normal, complete.	Lacking suboperculum and sometimes operculum.
Brain case	Not ossified laterally between orbits.	Ossified laterally between orbits.	Ossified laterally between orbits.
Parietals	Distinct from supraoccipital.	Distinct from supraoccipital.	Usually fused with the supra occipital which is greatly developed.
Adipose dorsal	Often present	Absent	Often present
"Interclavicles"	Absent	Absent	Present.
Parapophyses on precaudal vertebræ	Absent	Absent	Often present
Pyloric cæca	Often present	Absent	?

Order **Ostariophysi** (*cont'd*).

Suborder **Nematognathi**[1] *Gill*

The Catfishes.

The name Nematognathi refers to the reduction of the maxillary to a slender element bearing the thread-like barbels; the premaxillaries alone forming the margin of the upper jaw.[2] Barbels are always present; the premaxillaries are not protractile, jaw-teeth if present are limited to the premaxillaries; the skull (as in Carps) is closed at the side by the orbitosphenoids and ethmoid; the supraoccipital is greatly developed. and usually fused with the parietals; an adipose dorsal fin is often present. The Catfishes show certain resemblances to the Acipenseroidei, in that: (1) the skin is naked, or armed with either bony scutes or plates; (2) the suboperculum is absent; (3) certain forms (*Doras*) exhibit fulcra-like scutes on the anterior border of the median fins; (4) the clavicles are braced inferiorly by infraclavicular plates. The latter, however, are not generally

[1] νῆμα, thread, γνάθος, jaw.

[2] Except in *Diplomystes* (Eigenmann.)

regarded as homologous with the infraclavicles seen in Ganoids and all the resemblances to the Acipenseroidei are doubtless analogical, not homological.

In the armored forms an elaborate system of tuberculated bony plates protects the head and shoulders (in a manner analogous to the plates of Dinichthyids among Arthrodires), and is supported posteriorly by the coalesced neural arches and by the stout shoulder girdle. The anterior fin ray, in the pectoral and dorsal fins, forms a great bony spine, which is erected and locked (in the dorsals) by an ingenious modification of the underlying neural spines, or (in the pectorals) of the basals.

The adaptive radiation of structure and habit among the 1000 species of Siluroids is extraordinarily great, and may indicate a great antiquity for the group; but many seemingly annectant forms still exist, and Eigenmann[1] traces all the higher subfamilies back to the American Diplomysteidæ, which retain dentigerous maxillaries forming part of the border of the mouth.[2] Fossil forms are rare. *Rhineastes* from the Wasatch or Lower Eocene of North America is probably related to the Pimelodinæ, from which, says Eigenmann,[3] "the present North American forms are, not unlikely, lineal descents." The gigantic Leopard Catfish *Bagarius yarreli of* India and Java is represented in the Pliocene of the Siwalik Hills in Northern India.

Although some of the genera belonging to the least specialized subfamilies Pimelodinæ and Tachisurinæ are marine, the majority of Catfishes shun competition with the higher Teleosts by living in muddy instead of clear water, a fact which may have determined the survival of the group. In correlation with this habit: (1) the eyes are often comparatively small; (2) the direction in which food lies is detected by the barbels or even by the skin, both of which in the naked forms are sensitively gustatory as well as tactile in function (Herrick); (3) in many genera the

1 "Revision of the South American Nematognathi or Catfishes," *Calif. Acad. of Science*, Occasional Papers, Vol. I, 1890.

2 The single genus *Diplomystes* should not be confused with the Clupeoid genus *Diplomystus*.

3 "A Catalogue of the Fresh-Water Fishes of South America," *Proc. U. S. Nat. Mus.*, Vol. XIV, 1891, p. 281.

difficulties of respiration in muddy water have been met by the development of accessory organs enabling the fish to take oxygen directly from the air. As in the case of certain Dipnoi, this condition has made possible more or less amphibious or even terrestrial habits, with correlated specializations for locomotion. Thus *Doras*, one of the South American forms, moves rapidly on land, "projecting itself forward on the pectoral spines by the elastic spring of the tail, travelling long journeys overland from one drying pond to another, spending whole nights on the way." Equally noteworthy are such bizarre forms as *Malapterurus*, the Electric Catfish, the completely cuirassed *Callichthys*, *Chætostomus*, *Loricaria*, the Sucking Catfish *Pseudecheneis*, and the parasitic Bdellostoma-like *Vandellia.*

Order **Ostariophysi** (*cont'd*).

Suborder **Eventognathi**[1] *Gill.*

(Plectospondyli *Cope* in part.)

The Carps.

In the Carps the food is sucked in by the toothless protrusile mouth and is masticated in the throat by the falcate toothed lower pharyngeals, which thus function like the jaws of other fishes. To this fact the name Eventognathi refers. In contrast with the Catfishes, the Carps have no spine in the fins, the broad parietals are distinct from the supraoccipital, the opercular apparatus is complete (i. e. the suboperculum is present), scales are usually present and there are no infraclavicular plates, nor an adipose dorsal fin. On the other hand, a suggestive agreement with the Catfishes is expressed in the naked head, the frequent presence of barbels, the frequency with which the premaxillary alone forms the margin of the upper jaw, and the closure of the brain case laterally by the orbitosphenoids and ethmoid; while further points of agreement with the Catfishes are found under the ordinal characters of the Ostariophysi (p. 473). Again, some of the Loaches parallel certain of the Catfishes, in (1) the elongation of the body, (2) the reduction of the scales, (3) the presence of an erectile, defensive spine (in this case suborbital), (4) the

[1] εὖ, well. ἐντός, within, γνάθος, jaw.

presence of six barbels, (5) the inferior position of the mouth, (6) the fact that the air bladder is in immediate contact with the skin; and these independently acquired characters seem to indicate the possession of "a potential of similar evolution" by ancestors of each of the groups.

The order does not present as wide a range of variation as do the Nematognathi, possibly because of its more recent origin. There are four families: (1) The Catostomidæ or Suckers (e.g. *Ictiobus*) are the more primitive, in that the maxillary forms part of the margin of the upper jaw while the pharyngeal teeth are very numerous. On the other hand, in (2) the Cyprinidæ or true Carps, the maxillary does not form part of the margin of the upper jaw, simply assisting in the protrusion of the mouth, while the pharyngeal teeth are reduced in number. About 200 genera and nearly 1000 species are known (Jordan). The North American genera while very closely related, are separated by characters which although reasonably constant are often of slight structural importance (Jordan) An interesting specialization is the highly colored breeding dress of the males. (3) The Cobitidæ or Loaches (described above). (4) The Homalopteridæ, mountain forms with depressed head and horizontally expanded paired fins "which sometimes form a sucking disk." All members of the order inhabit freshwater. Fossil forms date from the Upper Tertiary and are closely allied to or identical with living genera. The Eventognathi are probably "modern" (Middle Tertiary) offshoots of the ostariophysan stem. The union of the Eventognathi (Carps) with the Heterognathi (Characins) into the order Plectospondyli while justly expressing the ultimate kinship of these two groups arbitrarily separates them from the Nematognathi (Catfishes).

Superorder UNCERTAIN.

Order **Apodes**[1] *Linnæus.*

The Eels.

(Plate XXIX.)

Under this name Linnæus grouped many wholly unrelated forms

[1] ἀ, without, πούς, foot, from the absence of pelvic fins.

which had independently lost the pelvic fins (Cf. Appendix I). By successive eliminations the order has been restricted to include only the Eels proper and their near allies, and the Morays.

"The typical Apodes are unique among the so-called teleostean fishes in possessing more than five basal bones in the pectoral fin—a feature characteristic of all the lower groups of Actinopterygii (A. S. Woodward[1])." They agree with the other physostomes (Isospondyli, Ostariophysi, Haplomi, etc.) in the following primitive characters: (1) the air bladder (if present) communicates with the digestive tract by a duct, (2) the fins have no spines, (3) the small supraoccipital is separated from the frontals by the distinct parietals. They agree with the Haplomi, Iniomi, and higher Teleosts in the absence of the precoracoid (mesocoracoid) arch. The Apodes are especially distinguished by the following combination of characters. (1) the lack of any bony connection between the skull and the shoulder girdle which is in fact separated entirely from the skull. (2) The absence of the premaxillaries, which are functionally replaced by the dentigerous vomer. (3) The coalescence of the vomer with the ethmoid (4) The reciprocal development of the maxillaries and pterygopalatines, which functionally replace each other in different families. (5) The reduction of the opercular bones, which are deeply sunk in the integument. (6) The absence of the symplectic, or possibly its non-separation from the hyomandibular. (7) The absence of pelvic fins (except in the Anguillavidæ (Hay) of the Cretaceous, p. 481). (8) The multiplication of the vertebræ (up to 225). (9) The anguilliform body. (10) The disappearance or extreme reduction of the scales. (11) The loss of the homocercal tail (vestiges of which seem to persist in *Simenchelys* and which was well developed in the Cretaceous genera *Urenchelys* and *Anguillavus*). (12) The union of the dorsal and anal fins with the tail-fin into the gephyrocercal form. (13) The occasional reduction of the vertical fins.

The order seems to be an offshoot from some long-bodied Cretaceous Actinopteran with weak premaxillaries, slender, toothed maxillaries, teeth on the vomers and pterygopalatines. The question of their relationship to the Isospondyli is not settled.

[1]*Cat. Foss. Fishes, Brit. Mus.*, Part IV, 1901, p. x.

On account (1) of their having more than five basal bones in the pectoral fin, and (2) of the presence of true Eels in the Cretaceous period, Dr. Smith Woodward[1] is of the opinion that the Apodes are not degenerate offshoots from the Isospondyli as here defined, but independent derivatives from some Holostean Ganoids. The ancestral Apodes were possibly pelagic, subsequently invading the rivers and giving off the fresh-water eels. These still require the salt water for the development of the reproductive organs, and undergo a remarkable metamorphosis, passing through a 'Leptocephalus' or Glass-eel stage quite similar to that of the Albulids among Isospondyles Extremely predatory and voracious, sometimes becoming semiparasitic (*Simenchelys;* compare similar results among Cyclostomes). Swimming rapidly by lateral undulations, hence not requiring a homocercal tail for propulsion. Teeth primarily adapted for seizing and holding a struggling prey. The reduction of the maxillaries their functional replacement by the more advantageously placed pterygopalatines, and the separation of the latter from the quadrate, finally resulting (in the Morays) in a large snake-like and very loose jaw-apparatus with backwardly inclined suspensorium; these changes in turn necessitating the great reduction of the branchial and opercular bones, the total separation of the shoulder girdle from the skull, and the development of large branchial pouches for sucking in water.

The classification here adopted is as follows:

Order **Apodes** *(Linn.) Kaup.*

Suborder 1. **Archencheli** *Jordan*

Fam. Anguillavidæ Hay. Up. Cretaceous, Mount Lebanon, Syria.

Suborder 2. **Enchelycephali** *Cope*

Fam. Anguillidæ (Eels)

" Nemichthyidæ (Thread Eels)

" Synaphobranchidæ

Suborder 3. **Colocephali** *Cope*

Fam. Murænidæ (Morays)

[1] *Op. Cit.*, p. x.

Suborder 4. **Carencheli**[1] *Gill*
Fam. Derichthyidæ
Suborder 5. **Lyomeri**[1] *Gill and Ryder*
Fam. Saccopharyngidæ (Gulpers)

(1) **Archencheli.** Upper Cretaceous "Apodes with well-developed cleithrum, pectoral arch, pectoral and ventral fins, and a distinct caudal fin . . . Palatopterygoid arch developed. Scales rudimentary [vestigial] or absent; in some cases a row of enlarged plates on each side, probably on the lateral lines. Ribs present. One genus *Anguillavus*" (Hay[2] 1903, p. 436).

(2) **Enchelycephali** *Cope* (ἔγχελυς, eel, κεφαλή, head), including according to Gill and Jordan, the Anguillidæ or true Eels, Simenchelyidæ (Pug-nosed Eels), Ilyophidæ (Ooze Eels), Synaphobranchidæ (Deep Sea Congers), Leptocephalidæ (Conger Eels), Murænesocidæ, Nettastomidæ (Sorcerers), Nemichthyidæ (Snipe Eels), Myridæ (Worm Eels), Ophichthyidæ (Snake Eels); these are all (except Nemichthyidæ) included in the family Anguillidæ by Boulenger. In these the gill openings are well developed, leading to large interbranchial slits, the tongue is present, the opercles and branchial bones are well developed, the scapular arch is present.

(3) Suborder **Colocephali** *Cope* (κόλος, defective, κεφαλή, head), including according to the American school the Murænidæ (Morays), Myrocongridæ, Moringuidæ; these are all called Murænidæ by Boulenger. In this highly degenerate group the gill openings are small, rounded, leading to restricted interbranchial slits, the tongue is wanting, the pectoral fins (typically) are wanting, the opercles reduced, the fourth gill arch modified, strengthened, and supporting pharyngeal jaws, the maxillaries are functionally replaced by the toothed palatopterygoid, the premaxillaries by the toothed ethmovomer.

(4) Suborder **Carencheli.** According to Gill these deep-sea forms differ from the true Eels and Morays in the retention of

[1] Of more or less uncertain relationship to the typical Apodes; may deserve separate ordinal rank.

[2] Hay, O. P. "Cretaceous Fishes from Mount Lebanon, Syria," *Bull. Am. Mus. Nat. Hist.*, Vol. XIX, 1902.

premaxillaries, which are united by suture with the maxillaries, and immovably connected with the cranium.

(5) Suborder **Lyomeri** (*Gill and Ryder*). According to Boulenger the very anomalous abyssal forms known as Saccopharyngidæ (Gulpers), formerly set apart as a distinct order Lyomeri, may be regarded as extremely degraded Eels, possibly related to the Synaphobranchidæ, which have entirely lost the pterygopalatine arch, the branchiostegal rays, and the pharyngeal bones, the enormous slender jaws being loosely slung from the cranium by means of the slender hyomandibular and quadrate.

Superorder Uncertain (*cont'd*).
Order **Symbranchii**[1] *Gill.*

These extraordinarily eel-like and apodal forms[2] are distinguished from the true Apodes by the following fundamental characters: (1) The more normal structure of the skull, in which the symplectic and metapterygoid are present, and the premaxillary is well developed, forming the greater part of the oral border. (2) In the more generalized family (Symbranchidæ) the shoulder girdle is attached to the skull through the well-developed forked posttemporal, but in the Amphipnoidæ the absence of the posttemporal leaves the shoulder girdle free from the skull, as in Apodes. (3) The gill openings on both sides are confluent into a single slit beneath the throat. (4) All known members of the group parallel *Lepidosiren* and *Protopterus* among the Dipnoi, both in environment and in habits. The Amphipnoidæ possess lung-like respiratory diverticula of the branchial chamber, on each side of the neck, which are capable of taking oxygen directly from the air. From the structure of the skull we may infer that the Symbranchii are allied to the Isospondyli or possibly to the Haplomi.

Superorder Uncertain (*cont'd*).
Order **Heteromi**[3] (*Gill*).

[1] σύν, together, βράγχια, gills, in allusion to confluence of the gill openings into a single ventral slit.

[2] Compare Appendix I.

[3] ἕτερος, one of two, ὦμος, shoulder, possibly in allusion to the attachment of the shoulder to either the supraoccipital or the epiotic.

The Halosauries, Thornbacks, etc.

This order as defined by Boulenger embraces certain eel-like[1] deep-sea fishes formerly assigned to the suborders Lyopomi Gill (Halosauridæ) and Heteromi Gill (Notacanthidæ), together with the more recently discovered Lipogenyidæ which are said to bridge over the gap between these two groups. To these Boulenger adds the marine Fierasferidæ and the Cretaceous Dercetidæ. All these families retain archaic or Isospondylous characters in the abdominal position of the many-rayed ventral fins (when present), especially in the union of the broad parietals along the median line which widely separates the supraoccipital from the frontals. "They are all characterized," says Smith Woodward,[1] "by a primitive cranium of the Jurassic type; but they exhibit the new specialization by which the extending premaxilla gradually excludes the maxilla from the upper border of the mouth. Their elongated shape alone is indicative of high specialization; but no intermediate forms are yet known to afford a clue to their more normally shaped ancestors." On the other hand, they parallel the Acanthopteroidei in the closure of the air bladder, in the absence of the mesocoracoid arch, and in the frequent appearance of spines in the fins. The pectoral arch is suspended from the supraoccipital or the epiotic (as in the Iniomi), the posttemporal is small and simple, or replaced by a ligament. The group parallels the Macruridæ among the Anacanthini and many other eel-like forms in the loss of the homocercal tail (which is, however, preserved in the Cretaceous Dercetidæ) and its replacement by the hypocercal type (Appendix II).

The existing *Halosaurus* "cannot be clearly distinguished from the Cretaceous *Echidnocephalus;* while *Notacanthus* of the present fauna only seems to differ from *Protonotacanthus* of the Cretaceous period in the possession of dorsal spines and fin-rays. The Dercetidæ, on the other hand, are only known by fossils from Cretaceous formations, in which they are widely distributed. They are interesting as being the earliest type of fish in which evidence of a distensible stomach has been observed. . . .

[1] See Appendix I.

[2] *Cat. Foss. Fishes, Brit Mus.*, Part IV, 1901, p. viii.

Their fins are less specialized than those of the . . . [Halosauridæ and Notacanthidæ] and their trunk is provided with paired longitudinal series of enlarged scutes [Compare *Eurypholis* among Scopeloids]." (Smith Woodward *loc. cit.*)

Jordan is sceptical as to the naturalness of this assemblage (1905, p. 484) especially as to the inclusion of the Fierasferidæ. Possibly this order might be included in the superorder Mesichthyes defined below (p. 484), but the retention of the very archaic type of cranium militates somewhat against this association. On the other hand the closure of the air bladder, absence of the mesocoracoid arch, and frequent appearance of spines in the fins seem to separate the group from the Malacopterygii. It may prove advisable eventually to raise the group to superordinal rank, coordinate with the Mesichthyes, Thoracostraci, etc., retaining the divisions Lyopomi and Heteromi as orders.

Superorder MESICHTHYES[1] (*Hay*) *mihi*.

(Plate XXIX.)

The groups of families known as Iniomi (Scopeloids), Haplomi (Pikes, etc.), Salmopercæ (Sand-rollers), Synentognathi (Flying-fishes, etc.), are all doubtless descended from various soft-rayed, isospondylous, or perhaps even Holostean stocks which had evolved more or less toward the spiny-finned or physoclistous type of structure. Hence these intermediate groups present numerous combinations of the leading characters which distinguish typical soft-rayed and spiny-finned fishes. For example, in some of them (Synentognathi) we find abdominal ventrals and soft or non-articulated rays (Isospondyl characters), in combination with a closed air bladder (acanthopterous character), while in others (Percopsidæ), which are referred by Boulenger to the Haplomi, an open air bladder, and an adipose dorsal fin persist in combination with forwardly displaced ventrals and spines in the fins. Hence as the passage from typical soft-finned. physostomous, to spiny-finned and physoclistous fishes is very gradual systematists have experienced difficulty in segregating

[1] μέσος, middle, ἴχθυς, fish, in allusion to the transitional character of the group.

ordinal assemblages around central forms without disrupting natural connections at the peripheries. Although, as implied by Jordan, any such attempt must over-emphasize certain breaks in the sequence, yet on the whole the least distortion of natural relationships seems to be secured in the following scheme. The group Mesichthyes Hay,[1] proposed as an order to include the Haplomi, the Synentognathi, and the Percesoces, is here modified by the addition of the Iniomi to the Haplomi, by the transference of the Percesoces to the Acanthopterygii, and by the inclusion in it of the order Salmopercæ Jordan and Evermann, the whole group being raised to superordinal rank, coördinate with the superorders Malacopteroidei, Thoracostraci, Acanthopteroidei. In defense of this procedure I may say, first, that the close connection between the Iniomi and Haplomi has led Boulenger to merge the Iniomi in the Haplomi. Second, the removal of the Percesoces to the Acanthopteroidei (already advocated by Jordan and Evermann) is justified by the fact that in the Percesoces for the first time among fishes with a closed air bladder appear (1) a separate spinous dorsal, (2) the connection of the pelvis with the clavicular arch, (3) the reduction of rays in the ventrals to one spine and five soft rays. These characters (usually found among the Percesoces in combination) serve to separate them sharply from their supposed near allies, the Synentognathi. Third, as to the inclusion of the Salmopercæ in the Mesichthyes, Boulenger unhesitatingly pronounces the Sand-rollers to be progressive Haplomi, but it seems better to regard them as coordinate in rank with that group.

As constituted above the superorder may be separated from the Malacopterygii by (1) the absence of the mesocoracoid arch (a character believed by Swinnerton,[2] from the evidence of embryology, to indicate a very ancient separation from the Malacopterygii) and (2) (apparently) by the absence of the orbitosphenoid. From the Thoracostraci the superorder may

[1] "Bibliography and Catalogue of the Fossil Vertebrata of North America," *Bull. U. S. Geol. Surv., No. 179*, Washington, 1902, p. 397.

[2] "A Contribution to the Morphology and Development of the Pectoral Skeleton of the Teleosteans," *Quar. Jour. Micros. Sci.*, n. s., No. 1941, Vol. 49, Part 2, 1905, pp. 363–382.

be separated by the normal characters of the gills and coracoid, from the Acanthopteroidei by either (1) the abdominal or subabdominal position of the ventral fins, which (save in Percopsidæ) are entirely separated from the pectoral arch, or (2) by the feeble development of spines in the fins, or (3) in the Haplomi, Salmopercæ by the open air bladder, or (4) by the high number of rays (usually more than six) in the ventrals.

The adipose dorsal fin seen in Salmonidæ, Nematognathi, Characinidæ among Malacopteroidei is retained in some families (Scopelidæ, Alepidosauridæ, Percopsidæ) of the present superorder. The number of rays in the ventral fins is progressively reduced as follows: Iniomi 10 to 5, Haplomi 11 to 3, Salmopercæ 9, Synentognathi 6, the number thus being higher, as a rule, than in the Acanthopteroidei. The inarticulated rays or spines in the fins exhibit various stages of development but are never numerous: absent or at most incipient in Scopeloids and true Haplomi, Synentognathi, distinct but very few in Salmopercæ. A separate spinous dorsal is never developed. The soft dorsal is nearly always well back (save in Salmopercæ) usually opposite or nearly opposite the (usually short) anal. The parietals are usually (save in Galaxoidea) separated by the supraoccipital. By this character the Mesichthyes may be separated from the Heteromi, from which they are further distinguished by the normal non-anguilliform body and the broadly homocercal tail.

Our division of the superorder is as follows:

Superorder MESICHTHYES (*Hay*) *mihi.*

Order 1. **Haplomi** (*Gill*) *Boulenger*

Superfamily Aulopoidea (*Gill*) (Iniomi *Gill*)
" Esocoidea *Starks*
" Dalloidea nom. nov.
" Pœciloidea *Starks*
" Amblyopsoidea *Starks*
" Stephanoberycoidea nom. nov.
(Incertæ Sedis)
Fam. Chirothricidæ (af. Iniomi?)
" Kneriidæ
Superfamily Galaxoidea nom. nov. (af. Isospondyli?)

Order 2. **Salmopercæ** *Jordan and Evermann*
Fam. Percopsidæ
Order 3. **Synentognanthi** *Gill*
Fam. Belonidæ
" Exocœtidæ

Superorder Mesichthyes (*Hay*) (*cont'd*).
(Plate XXIX.)

Order 1. **Haplomi**[1] (*Gill*) *Boulenger*

The superfamily **Aulopoidea** (Iniomi[2]), represented by a few shore species and many deep-sea forms, combine characters of the Salmonoid Isospondyli and of the Haplomi. In so far as the osteology is known they differ from the Isospondyli in the absence of the mesocoracoid arch in the shoulder girdle and of the orbitosphenoid in the skull and thus the group falls within Boulenger's definition of the Haplomi; while on account of the close relationship of the Alepidosauridæ to the more generalized Enchodontidæ of the Cretaceous Smith Woodward includes them all in the Isospondyli. In the Scopelidæ, the posttemporal is forked and (as in the Salmonidæ, Clupeidæ) the upper branch meets the epiotic, the lower the opisthotic, but here, not as in the Isospondyli, the posttemporal merely touches and is not firmly attached to the skull. In the Alepidosauridæ the upper branch of the supratemporal is lacking, the simple supratemporal being attached on the side of the occiput to the opisthotic. To this peculiar mode of attachment of the shoulder girdle to the skull at the nape the word Iniomi alludes. As in other Haplomi and progressive Isospondyli the supraoccipital has thrust aside the parietals to gain contact with the frontals, and sometimes, as in the Salmonidæ, is itself partly overlapped by the parietals. The most primitive genera (*Aulops*, *Chlorophthalmus*) retain the Salmonoid adipose dorsal, a normal maxillary (*fide* Jordan) and show no luminous spots. In the more specialized genera

[1] ἁπλοῦς, simple, ὦμος, shoulder, in allusion to the want of the mesocoracoid.

[2] ἴνιον, nape, ὦμος, shoulder.

the adipose dorsal is frequently lost, the premaxillaries lengthen and grow fast to the slender maxillary which is excluded from the oral border (Boulenger), and an elaborate system of photophores is developed. The group is known from numerous fossil genera in the Cretaceous and Eocene.

The **Chirothricidæ** (Cretaceous forms) are probably related to the Scopeloids, but superficially resemble Flying-fishes (*Exocœtus*). The "wings," however, are formed by the greatly enlarged ventral fins, which are placed very far forward.

The Cretaceous **Enchodontidæ** are said to agree with contemporary Isospondyls in most respects, but are progressive in the backward enlargement of the delicate premaxilla, which nearly excludes the maxilla from the border of the mouth. The long, slender teeth are acrodont (*i.e.*, not in sockets but fused with the supporting bone). An adipose fin is often present. Their nearest existing relatives are the deep-sea Alepisauridæ.

The true **Haplomi** as understood by Gill, Jordan, and Starks, include only the Mud-minnows (**Umbridæ**) and Pikes (**Esocidæ**) of Europe, Asia, and America, the Killifishes (**Pœciliidæ** or **Cyprinodontidæ**) of Southern Europe, Africa, Asia, and America, and the famous subterranean Blind-fishes (**Amblyopsidæ**) of the southern United States. These families have been grouped by E. C. Starks[1] in a recent paper on the osteology of the Haplomi as follows:

	Superfamily	Esocoidea	Esocidæ (Pikes)
			Umbridæ (Mud-minnows)
Order Haplomi	"	Pœciloidea	Pœciliidæ (Killifishes)
			Cyprinodontinæ
			Pœciliinæ
	"	Amblyopsoidea	Amblyopsidæ (Blind-fishes)

"The families of the Haplomi," he says, "have either widely diverged from each other or are not of the same line of descent. The order is not held together by any important character, though some very peculiar characters may be used to rather widely separate three groups."

[1] "A Synopsis of Characters of Some Fishes belonging to the Order Haplomi," *Biological Bull.*, Vol. VII, No. 5, Oct. 1904, pp. 254-262.

The order as thus constituted is trenchantly separated by the loss of the mesocoracoid from the Isospondyli, with which it agrees in: (1) the suspension of the shoulder girdle from the skull by the posttemporal, (2) the abdominal position of the pelvic fins, (3) the persistence of the pneumatic duct connecting the air bladder with the gut, (4) the soft-rayed character of the fins. The derivation of the group from Cretaceous Isospondyls is probable. "The Esocidæ" says Dr. Smith Woodward,[1] "are essentially fresh-water Scopeloids, and the Cyprinodontidæ [Pœciliidæ] are generally admitted to be closely allied to this family. Nothing of importance is known concerning their geological history." Jordan and Starks mention the following additional characters as defining the Haplomi proper: (5) alisphenoids not meeting in a median line in front of brain case, (6) the supraoccipital wedges in between the parietals (a morphological advance beyond the more primitive families of Isospondyli), (7) the exoccipitals are separated by the basioccipital, a frequent character among the lower Teleosts (Starks), (8) the post-clavicle is composed of a single element, (9) actinosts four, (10) opercular bones all present, (11) pectoral fins placed low, (12) dorsal fin placed more or less posteriorly, (13) head usually covered with cycloid scales like those on the body.

To this assemblage Boulenger[2] adds besides the forms usually called Iniomi the following families, and adopts a more elastic definition of the order Haplomi.

1. **Galaxiidæ** or Southern Pikelets. This family and the nearly related Haplochitonidæ are more primitive than the true Pikes (Esocidæ) in that: (1) the supraoccipital has not yet pushed aside the parietals to gain contact with the frontals, (2) an adipose fin (in the Haplochitonidæ) is present. Swinnerton[3] says of *Galaxias*, "In some respects, *e.g.*, forward extension of the cranial cavity, and the condition of the articular head of the hyomandibular, it is as lowly as, or even more lowly than, the salmon."

[1] *Cat. Foss. Fishes, Brit. Mus.*, Part IV, 1901, p. ix.

[2] Boulenger, G. A., *Cambr. Nat. Hist.*, Vol. "Fishes," p. 605.

[3] "The Osteology of *Cromeria nilotica* and *Galaxias attenuatus*," *Zool. Jahrb.*, 1903, Bd. XVIII, pp. 58–70.

These characters and the many similarities to the Salmonidæ incline Jordan to regard the Galaxiidæ and Haplochitonidæ as Isospondyls. But they lack the mesocoracoid, and Boulenger has consequently placed them with the Haplomi. In order to express their wide differences from the typical Haplomi we set them apart from the Esocoidea in a coördinate superfamily Galaxoidea. Boulenger shows that the present range of the group in Southern Africa, Australia, New Zealand, and South America may be accounted for by the fact that the genus *Galaxias* is not confined to fresh waters but occurs also in the sea.

2. The **Dalliidæ** or Alaska Black Fishes. These peculiar forms, in which the coracoids are coalesced and cartilaginous and the actinosts are represented by a longitudinally divided and distally fringed cartilaginous plate, were set apart by Gill as the order Xenomi; but their close relationship to the true Haplomi has been demonstrated by Starks.[1] We may provisionally assign them to a separate superfamily, the Dalloidea.

3. The **Stephanoberycidæ** (Crowned Beryces). "This [abyssal] family has hitherto been placed near the Berycidæ, among the Acanthopterygii, but there are no spinous rays in the dorsal and anal fins, and the ventrals formed of one simple and four or five branched rays are abdominal" (Boulenger.) The air bladder has a wide duct (Boulenger). Mr. Tate Regan (see p.498) regards this family as possibly related to the ancestors of the Anacanthini or Cods. Gill suggests that the Stephanoberycidæ may be degraded berycoids in which the ventral fins have lost their normal connection with the clavicle.

4. The **Percopsidæ**. The Sand-rollers inhabit the Great Lakes, the rivers and streams of the northern Mississippi valley and of Canada, and the Columbia River. This family (represented in the present fauna by only two genera, each with a single species) is of extraordinary interest, since, according to Jordan and Evermann, it is apparently derived directly from "the extinct transitional forms through which the Haplomi and Acanthopterygii have descended from allies of the Isospondyli. The group shows the remarkable combination of true fin spines,

[1] "The Osteology of *Dallia pectoralis*." *Zool. Jahrb.*, Bd. XXI, Heft 3 1904, pp. 249–262.

ctenoid scales, and a percoid mouth [Acanthopterygian characters] with the adipose fin [also open air duct], abdominal ventrals, and naked head of the Isospondyli" (Jordan and Evermann). "The relations of the Percopsidæ with such archaic spiny-rayed fishes as *Aphredoderus* and *Elassoma* are certainly not remote, and the close resemblance of the head of *Percopsis* to that of *Gymnocephalus* (*Acerina*) [the Ruffe of the Percidæ] may be more than accidental" (Jordan). The family is made a suborder (Salmopercæ) of the Acanthopteri by Jordan and Evermann with the following definition: "Adipose fin present; dorsal and anal with spines in very small number; ventral fins abdominal, with more than 5 soft rays [9], vertebræ about 35." On the other hand, Boulenger believes that "an analysis of their characters shows them to belong to the Haplomi, of which they may be regarded as highly specialized members having evolved in the direction of the Acanthopterygii." By Boulenger the degree of separation from other Haplomi is indicated in the synopsis of families (p. 606) as follows: "Dorsal and anal fins with true spines; scales ctenoid; an adipose dorsal; ventral fins with 9 rays." These characters taken together appear to us to justify the ordinal separation of the Percopsidæ from the Haplomi.

(5) **Cobitopsidæ.** The Oligocene genus *Cobitopsis* may belong with the Haplomi or Synentognathi. The family Ammodytidæ may be related to the Cobitopsidæ (Boulenger), or since one of them, *Embolichthys*, has the ventrals beneath the throat (jugular) the family may be allied to the Percophiidæ among the Acanthopterygii Jugulares (Gill, Jordan)—another instance of the confusingly close analogical remembrances so frequent among teleostome fishes.

Superorder MESICHTHYES (*cont'd*)

Order **Synentognathi**[1] *Gill.*

(Plate XXIX.)

The Needle Fishes and Flying Fishes.

Jordan (1905, pp. 208–214) divides the group into two families

[1] σύν, together, ἐντός, within, γνάθος, jaw, in allusion to the fusion of the lower pharyngeals.

as follows: (1) **Belonidæ,** the Garfishes. These have strong jaws and teeth, the third upper pharyngeal is small with few teeth, the maxillary is firmly soldered to the premaxillary and the vertebræ have zygapophyses. (2) **Exocœtidæ,** the Skippers (*Scombresox*), Half-beaks, and Flying-fishes. These have small and nearly equal teeth, the maxillary is separate from the premaxillary, the third upper pharyngeal is much enlarged, and there are no zygapophyses on the vertebræ. The genera *Hemiexocœtus* and *Fodiator* are intermediate in structure and in leaping or flying habits between the Half-beaks (*Hyporhamphus*, *Hemirhamphus*) and the true Flying-fishes. All these forms are included in the single family Scombresocidæ by Smith Woodward and Boulenger.

The order [1] retains archaic or isospondylous characters and agrees with the Haplomi in the lack of fin spines, and in the abdominal position of the ventrals, which have more than five rays; and a further agreement with the Haplomi is the absence of the mesocoracoid arch A possible representative of the coronoid of the lower jaw, is, however, retained. As in the Thoracostraci [2] (1) the open communication between the swim bladder and the gut has been lost (physoclistous condition), (2) the parietal bones are absent or well separated by the supraoccipital, (3) the exoccipitals are not united over the basioccipitals, (4) the scapula is suspended from the skull by a simple non-furcate posttemporal, and (5) the supraclavicle when present is small, (6) the postclavicle is absent, (7) parapophyses are developed on all the abdominal vertebræ (Starks[2]). In characters 1, 2, 3, 4, 5, 7, as well as in the high position of the pectoral fins and in many other characters, they agree with the typical Percesoces; and thus tend to connect the physostomes (represented by the Haplomi) with the physoclists.

The character to which the name Synentognathi refers is the complete union of the lower pharyngeals in the median line,

[1] Starks, E. C., "A Review of the Synentognathous Fishes of Japan," *Proc. U. S. National Mus.*, Vol. XXVI, 1904, pp. 525–544.

[2] Starks, E. C., "The Shoulder Girdle and Characteristic Osteology of the Hemibranchiate Fishes," *Proc. U. S. National Mus.*, Vol. XXV, 1902, pp. 619–634.

a condition independently acquired elsewhere, notably by the labroid or pharyngognathous fishes among Acanthopterygians. The upper pharyngeals are variously enlarged and afford good differential characters for splitting the group up into families (Starks, Jordan). A peculiar and characteristic detail is the position of the lateral line, which is concurrent with the belly. The Sauries (Scombresocidæ proper) "bear strong analogical resemblances to the mackerels in form, color, and habits, as well as in the dorsal and anal finlets" (Starks). Hence the name Scombresocidæ or mackerel pikes.

Belone and *Scombresox* are known from the Upper Miocene of Croatia and Algeria, while *Hemirhamphus* is recorded from the Upper Eocene of Monte Bolca near Verona, Italy. Jordan (1905, p. 214) suggests that the genera *Exocœtus*, *Exonautes*, and *Cypselurus* are of very recent [?Upper Tertiary] origin. Boulenger (1904, p. 632) thinks that *Protaulopsis*, hitherto referred to the Sea-horse assemblage may belong to the Synentognathi.

Superorder THORACOSTRACI[1] *Swinnerton.*

(Plate XXIX.)

This superorder, which has been shown by several authors to be a natural group, embraces (1) the order **Hemibranchii** of Cope, including the Gasterosteridæ or Sticklebacks, the Aulorhynchidæ or Tube-snouts, the Protosyngnathidæ, the Aulostomidæ, the Fistulariidæ or Cornet-fishes, the Macrorhamphosidæ or Snipe-fishes, the Centriscidæ, the Amphisilidæ; (2) the **Lophobranchii** of Cuvier, including the Solenostomatidæ or Tube-mouths, the Syngnathidæ or Pipe-fishes and Sea-horses. (The Pegasidæ which are usually treated as Lophobranchs are discussed on p. 505)

Setting aside for the moment the peculiar lines of specialization of this order, we have left certain primary ancestral characters in which the group resembles the Synentognathi and the

[1] *θώραξ*, thorax, *ὄστρακον*, potsherd, shelly test, in allusion to the shelly exoskeleton of many of the forms.

(Phthinobranchii *Hay*, Hemibranchii *Cope*, Lophobranchii *Cuvier*, Physoclisti in part.)

Percesosces, and thus represents a considerable advance upon the Isospondyli. These are the loss of the mesocoracoid, the lack of open communication between the swim bladder (when present), and the gut, the separation of the parietals by the supraoccipital. Archaic isospondylous characters are the abdominal or subabdominal position of the pelvic fins (when present), and the suspension of the shoulder girdle from the cranium by a bony posttemporal. The latter bone is simple, non-furcate, and immovably attached to or even fused with the cranium.

Progressive characters are the following: (1) In the ancestral types (the Sticklebacks which, as shown by Gill[1] lead beautifully into the Aulorhynchidæ) the pelvis is either free or attached to the backwardly produced coracoids (hypocoracoids), but this connection may be secondarily lost in the more specialized forms through partial atrophy of the shoulder girdle; (2) the coracoids (hypocoracoids) are much enlarged, forming so-called "infraclavicular plates" often enameled externally; (3) the anterior vertebræ (except in Gasterosteids) are more or less modified or coalesced, often forming a long tube; (4) the branchial arches are always more or less reduced; (5) the branchial lamellæ are pectinated (Hemibranchii), or produced into tufts (Lophobranchii); (6) the dorsal fin often has a spiny portion consisting of free spines, and the anal fin also occasionally develops a spine; (7) the snout in the Gasterosteidæ is either conical or but slightly tubiform, but in all the higher forms it is fully tubiform, the small mouth being terminal and bounded solely by the premaxillaries; (8) the scales are small (Fistulariidæ), reduced (Aulorhynchidæ), or absent (Gasterosteidæ), progressively superseded by bony scutes; the latter process culminates in the complete bony cuirass of *Amphisile*, which is fused with the enlarged ribs and other portions of the endoskeleton.

In discussing the probable affinities of the Hemibranchii and the Percesoces (excepting Sphyræna), Dr. Starks[2] enumerates the

[1] Gill "On the Mutual Relations of the Hemibranchiate Fishes," *Proc. Acad. Nat. Sci. Phila.*, 1884, p. 154.

[2] "The Shoulder Girdle and Characteristic Osteology of the Hemibranchiate Fishes." *Proc. U. S. Nat. Mus.*, Vol. XXV, 1902, p. 622

following characters as common to both groups: (1) the parapophyses are developed on all the abdominal vertebræ; (2) the supraclavicle when present is small; (3) the exoccipitals are not united above the basioccipital; (4) the supraclavicle, when present is reduced in size; (5) *Fistularia* and *Aulostomus* have processes running backward from the epiotics, which are strikingly similar to the epiotic processes possessed by all the Percesoces. On the other hand, the Hemibranchs easily stand apart from the Percesoces "in having no opisthotics and usually no parietals; in having the posttemporals simple, not typically forked; and in having the clavicle composed of a single piece when present (composed of two pieces in the Percesoces)."

The most generalized form, *Gasterosteus*, is carnivorous and active, but the prey is the small "fry" of other fishes which the Sticklebacks seek out "with the utmost industry, sagacity, and greediness." The taste for minute prey to be sought by poking about in odd corners may have determined some of the peculiar specializations of the Sea-horse order. We may imagine these to have continually sought smaller and smaller food until the tiny particles came to be sucked up by the elongate muzzle. After probably passing through a stage somewhat like *Syngnathus* but less eel-like the ancestral Sea-horse did not need the quick-darting form of body to capture its food or escape enemies; hence the fan-like tail fin was suppressed (in *Hippocampus*), and the rapidly vibrating pectoral and dorsal fins enabled the fish to poise, humming-bird fashion, while sucking food through its tubular beak. The pectoral fins have been thought also to assist in drawing a steady current of water through the gill chamber. At a a very early period protection was secured by the development of an osseous cuirass and (in certain forms) of fucus-like outgrowths of the skin. Respiratory improvements consisted in the elaboration of tufted gills from the pectinate type. For the elaborate nesting habits and attentive care of the eggs by both sexes in the Sticklebacks, may have been substituted first the adhesion of the eggs to the abdomen of the male, then the development in the male of abdominal grooves and ridges to hold the eggs, finally, by fusion of opposite ridges, a perfected pouch.

Superorder ACANTHOPTEROIDEI[1] (nom. nov.)

(Plate XXIX.)

The superorder ACANTHOPTEROIDEI may be taken to include the orders Percesoces, Anacanthini, Labyrinthici, Acanthopterygii, Selenichthyes (Inc. Sedis), Tæniosomi, Plectognathi Hypostomides (Inc. Sedis.), Opisthomi, Pediculati. The air bladder if present is without open duct (save in certain Berycidæ), the parietals are always separated by the supraoccipitals, the mouth is usually "bordered by premaxillaries to the exclusion of the maxillaries, and if these should by exception enter the oral edge they are always toothless" (Boulenger). The orbitosphenoids are typically absent (retained in Berycidæ). The pectoral arch, typically of the Perciform type, is suspended from the skull (save in Opisthomi). There is no mesocoracoid. The ventral fins, if present, are usually below or in front of the pectorals. The pelvic bones, if present, are typically attached to the clavicular arch either movably and by ligament in most Percesoces and Nomeiformes or more firmly in Acanthopterygii and the remaining orders. Fins usually with spines, ventral fins typically with 1 spine and 5 soft rays. Scales various, typically ctenoid. Vertebræ typically 10 + 14 but frequently increased in number through "repetitive degeneration."

The superorder Acanthopteroidei represents the highest phases of piscine evolution or "ichthyization." From the swollen stream of central types realized in the Percesoces, the short-bodied scombroids, zeoids, berycoids, percoids, by centrifugal development many new types have been thrown off, which constitute an irregular but less thickly crowded zone of differentiation of the second degree, including such types as the long-bodied Scombroids, the Squamipinnes or Chætodontoids, the Pharyngognathi or Labroids, the Pareiopliteæ (Scorpænids, Cottids Triglids, etc.) the Jugulares (Blenniids, Trachinids, etc.) the Gobioids. Each of these in turn has become a new center or vortex of differentiation and they have thrown off such groups as the Heterosomata, the Plectognathi, the Hypostomides, Discocephali Opisthomi, Pediculati, which may be said to constitute the sparsely filled zone of differentiation of the third degree (Pl. XXIX)

[1] *Acanthopteri*, εἶδος, form.

Superorder ACANTHOPTEROIDEI (*cont'd*).
(Plate XXIX.)

Order **Percesoces**[1] *Cope.*

This group, being on the borderland between soft-rayed and spiny-finned fishes, may be classified with either, according to the characters selected to separate the spiny-finned fishes from the orders that lead up to them. Cope proposed the term to include only the Atherinidæ (Silversides), the Mugilidæ (Mullets), the Sphyrænidæ (Barracudas), but Smith Woodward and Boulenger[2] include not only the Synentognathi but also several families which are regarded by the American school as Acanthopterygii.

If we accept the term in its limited sense the order is readily defined from the Synentognathi, on the one hand, and from the true Acanthopterygii, on the other. Although certain Percesoces (e.g. *Atherina aræa*) show a general resemblance to the more generalized Synentognathi (e.g. *Chriodorus atherinoides*), and although fossil forms may be discovered, intermediate between the two orders, yet in the Percesoces a trenchant distinction from the Synentognaths and other physoclists with abdominal ventrals is afforded by the fins, in the appearance (1) of a separate spinous dorsal more or less remote from the soft dorsal, and (2) of an anterior spine in the pelvic fins. Furthermore the ventral fins are more forward than in the Synentognathi and the pelvic bones (save in Sphyrænidæ) are either attached to the backwardly produced postclavicles (Mugilidæ, Polynemidæ) or by ligament to the clavicular symphysis (Atherinidæ, Chiasmodontidæ). The ventral fin formula is now reduced to I, 5. In order to differentiate the Percesoces from the true Acanthopterygii "we must turn to the well known external characters—a spinous dorsal in conjunction with the abdominal ventral fins, high pectoral fins, and unarmed opercles [i.e. operculum and preoperculum without posterior spiny processes]." (Starks.[3])

[1] *Perca*, perch, *esox*, pike, in allusion to the mingling of ancathopterous and haplomous characters.

[2] *Cambr. Nat. Hist.*, Vol. "Fishes," etc., p. 636.

[3] Starks, E. C., "The Osteological Characters of the Fishes of the Suborder Percesoces," *Proc. U. S. Nat. Mus.*, Vol. XXII, 1899, pp. 1 *et seq.*

Starks shows that the skull and shoulder girdle of Sphyrænidæ, Atherinidæ, and Mugilidæ present a number of peculiar characters in common, among which are the following: (1) epiotics of adult produced backward and more or less divided into bristle-like filaments (2) supraoccipital developed posteriorly, not extending above level of balance of cranium, (3) postclavicle divided into superior and inferior parts (Starks).

The **Polynemidæ** or Threadfishes of the shores of the tropical seas, and the deep sea Chiasmodontidæ present many detailed resemblances[1] to the Sphyrænidæ-Atherinidæ-Mugilidæ group, and probably belong in the present order. Jordan ('96) notes the resemblance of this family to the Sciænidæ of the Acanthopterygii on the one hand and to the Mugilidæ of the present order on the other; but remarks that in both cases the resemblances may be merely analogical.

The **Crossognathidæ** (a Cretaceous family including *Crossognathus* and *Syllæmus* of the American Cretaceous) are regarded by Smith Woodward as forerunners of the Percesoces, *Crossognathus* agreeing very closely (so far as known) with the existing Atherines, but differing in having one continuous dorsal fin with the right and left halves of each spine not completely fused together (Smith Woodward),—a very primitive condition. However, Boulenger (1904, p. 565) believes that this family should probably be placed with or near the Clupeidæ among the Isospondyli. The earliest members of the families Mugilidæ, Sphyrænidæ, and Atherinidæ occur in the Upper Cretaceous of England, Colorado, and New Mexico. (Zittel, 1902).

Superorder ACANTHOPTEROIDEI (*cont'd*).

(Plate XXIX.)

Order **Anacanthini**[2] (*J. Muller*)

The Cods.

The order Anacanthini, properly including only the true Cods (Gadidæ) and their allies (Macruridæ, Muranolepididæ) was formerly burdened by the inclusion of the Heterosomata

[1] Boulenger, 1904, pp. 640, 641.

[2] ἀ, ἀνά, privative, ἄκανθα, thorn, spine, in allusion to the typically spineless condition of the anterior dorsal fin.

(Pleuronectidæ) or Flatfishes, but this association has been shown by Boulenger to be wholly unnatural. The Anacanthini differ from the Acanthopterygii chiefly in: (1) the lack of fin spines in the vertical and ventral fins (the first dorsal of some Macrurids has a single spiny ray); (2) in the feeble, ligamentous attachment of the pelvic bones to the pectoral arch; (3) the separation of the proötic from the exoccipital by the enlarged opisthotic; (4) the loss of the primary homocercal tail (Appendix II,) the caudal fin-supports of the seemingly homocercal tail of the Gadidæ being perfectly symmetrical above and below the vetebral axis and composed mainly of dorsal and anal rays (Boulenger[1]); (5) the position of the scapular foramen, which lies between the hypercoracoid (scapula) and hypocoracoid ("coracoid"), instead of perforating the hypercoracoid, as in most other Teleosts. However Tate Regan has shown that in one of the Macruridæ the position of this "scapular foramen" is normal. As in the typical Acanthopterygii the parietals are separated by the supraoccipital, the toothed premaxillaries alone enter the upper margin of the mouth, the maxillaries simply acting as levers for the protrusion of the mouth, the air bladder is without open duct, the ventral fins are below or in front of the pectorals.

Of the two principal families, Gadidæ and Macruridæ, the Macruridæ are believed by Tate Regan and Boulenger to be, on the whole, more primitive. "In the Macruridæ we pass from the more generalized forms with cycloid scales, terminal mouth, and continuous or subcontinuous dorsal fins, to those with rough or spinous scales, inferior mouth, and projecting snout, and a well differentiated anterior dorsal" (Tate Regan) Among the more central Macrurids the genus *Macruronus* closely resembles *Merlucius* of the Gadidæ in its skull, but is "a true Macrurid in the position of the ventrals and the absence of a caudal fin" (Tate Regan). In the Gadidæ the scales are reduced, the dorsal and anal fins are often divided into two or three portions, and a secondary fan-like tail is formed from the dorsal and anal fins. As to the derivation of the order, whether from true Acanthopterygians or from some less specialized stock, such as

[1]*Ann. and Mag. Nat. Hist.* (7) Vol X. Oct., 1002, p. 298.

the Haplomi, Mr. Tate Regan, who has carefully studied the osteology of the group, concludes that the absence of non-articulated fin rays, the large number of rays in the ventrals, and the lack of direct attachment of the pelvic bones to the clavicles, taken together, must be regarded as primitive features. "From their anatomy and appearance," he says, "I am inclined to think that the Gadoids are not related to the Percesoces, but are derived from some Haplomous stock from which the Berycidæ have also descended, and of which the Stephanoberycidæ may well be the living representatives."[1]

The group is typically carnivorous, marine, often abyssal. Fossil Gadoids are rare, but are recorded from the Eocene and Miocene.

Superorder ACANTHOPTEROIDEI (*cont'd*).

Order **Selenichthyes**[2] *Boulenger*

(Plate XXIX.)

The Opahs.

The systematic position of the Opah or Kingfish (Family Lamprididæ) is somewhat uncertain, but it seems entitled to occupy at least provisionally a separate order. It may be related either (1) to the Thoracostraci as held by Boulenger,[3] or (2) to such deep-bodied Scombroids as *Brama* and *Mene* (Gill),[4] or it may possibly be "transitional between deep-bodied extinct Ganoids [such as *Dorypterus*] and the forms allied to *Platax*, *Zeus*, and *Antigonia*" (Jordan). The Opahs resemble the Bramidæ in the heaviness of the shoulder girdle and in the great dilatation of the coracoid (hypocoracoid); superficially they

[1] "On the Systematic Position and Classification of the Gadoid or Anacanthine Fishes." *Ann. and Mag. Nat. Hist.* (7), Vol. XI, May, 1903, pp. 459–466.

[2] σελήνη, the moon, ἰχθύς, fish, in allusion to the gibbous form of the body.

[3] Boulenger, G. A., "Notes on the Classification of Teleostean Fishes. III. On the Systematic Position of the Genus Lampris, and on the Limits and Contents of the Suborder Catosteomi." *Ann. and Mag. Nat. Hist.*, Vol. 10 (Ser.), Aug., 1902, pp. 147–152.

[4] Gill, T. "On the Relations of the Fishes of the Family Lamprididæ or Opahs." *Proc. U. S. Nat. Mus.*, Vol. XXVI, 1903, pp. 915–924.

resemble *Mene* rather closely. The supposed relationships either to the Thoracostraci or to the Scombriformes turn upon the resemblances of the shoulder girdle to that of *Gasterosteus* among Thoracostraci and to that of such deep-bodied fishes as *Antigonia* among the Acanthopterygii. The Opah differs from typical Acanthopteri "in the absence of spines in the fins, and the position of the ventral fins, together with the great number of rays [14–17] in the latter, which is only met with in the lower Teleosteans" (Boulenger). Gill suggests that the attachment of the pelvis to the greatly enlarged hypocoracoids, as in the Gasterosteidæ, may be due to convergent evolution, and points out that the Opah agrees with the Mackerel-like fishes in a characteristic modification of the vertebræ and in "the deep bifurcation of the roots of the caudal rays which clamp the hypural and epural bones." The case is an instructive one as illustrating the difficulty, without knowledge of the less specialized members of a group, of deciding whether resemblances to some other group are genetic or convergent.

Order **Acanthopterygii** [1] *Cuvier*

The Spiny-rayed Fishes.

The structural characters enumerated under the superorder Acanthopteroidei (page 497) are here seen in their most typical condition. In addition, the opercle is always well developed. the gill opening usually large and in front of the base of the pectoral fin, the scapula is typically perforated by the scapular foramen, which may, however, appear between the scapula and the coracoid. It is not certain whether the order is polyphyletic, or, as usually held, monophyletic and derived from Cretaceous Berycidæ, which are generally conceded to be directly ancestral to the Perciformes. The Berycidæ retain such archaic characters as an open swim-bladder, an orbitosphenoid, and more than five soft rays in the ventrals. They are comparatively numerous in the Upper Cretaceous and may conceivably have given rise to the Stromateidæ through *Berycopsis*, to the deep-bodied Scombroids through the Pempheridæ, and to the Scor-

[1] ἀκανθα, a thorn, πτερύγιον, a fin, in allusion to the sharp spines in the fins.

pididæ through *Aipichthys*. On the other hand, all these and other deep-bodied families, such as the Bramidæ, Kurtidæ, Carangidæ, Menidæ, Bathyclupeidæ, Caproïdæ (Antigoniidæ), Zeidæ, Amphistiidæ, Chætodontidæ, may be the result of parallel evolution from *similar* but distantly related Cretaceous families. Some of the Acanthopterygii may have been derived from Cretaceous Percesoces (compare, for example, the suggestive resemblance of *Sciæna* to *Polynemus*), others from Cretaceous Haplomi (e. g. Berycidæ, Aphredoderidæ, from Percopsidæ). Again the presence of Berycidæ, Stromateidæ, Scorpididæ (*Aipichthys*), Sparidæ, in the Upper Cretaceous and the florescence of the order in the Eocene would push back the probable origin of the different sections of the order to the Middle Cretaceous, when very many Isospondyli and Haplomi were doubtless independently evolving in the direction of the Acanthopterygii At any rate all the ancestral Acanthopterygi probably were short-bodied, with the typical vertebral formula of 10 + 14, and all were in process of reducing the ventral fin-formula to I, 5 (Boulenger).

The Acanthopterygii very early enjoyed an adaptive radiation unequalled by that of any other order of fishes, so that by Lower Eocene times Scombroids, Percoids, Labroids, Plectognaths, Scorpænoids, Cottoids, Goboids, and Blennoids were already well differentiated. The history of the order since the Eocene is not fully known (Woodward).[1]

Superorder Acanthopteroidei (*cont'd*).

Order **Acanthopterygii** *Cuvier*.

Suborder **Percomorphi** *Cope*.

Division *Nomeiformes* (*divisio nova*).

There is considerable divergence of opinion as to the systematic position of the group of marine fishes formerly classified by Jordan under the families Nomeidæ or Portuguese-men-of-war-fishes, Centrolophidæ or Rudder-fishes, Stromateidæ or Butter-

[1] *Cat. Foss. Fishes, Brit. Mus.*, Part IV, 1901, p. xi.

fishes, Icosteidæ or Rag-fishes, Acrotidæ, Tetragonuridæ or Square-tails. By Gill and Jordan the first four families were placed with the Scombroidea after the Bramidæ or Pomfrets, while the Tetragonuridæ were segregated by Gill in a superfamily coördinate with the Scombroidea. Boulenger sinks the Nomeidæ and Centrolophidæ in the Stromateidæ, the Acrotidæ in the Icosteidæ, and believes that the near connection of the Tetragonuridæ with the Stromateidæ is shown by the common possession of œsophageal pouches beset with papillæ and gill-raker-like knobs below the pseudobranchiæ. Both families are pelagic or deep-sea, feeding on Crustaceans, the fry of other fish, or more frequently upon Medusæ, under the protection of whose stinging tentacles certain of them swim, as in the *Caranx medusicola* among Scombroids (Boulenger). The deep-sea Icosteidæ, which have a flimsy cartilaginous skeleton, lack the œsophageal teeth and the processes of the last gill arch, but *Icosteus* at least has the gillraker-like knobs below the pseudobranchiæ and the family is conceded by all to be allied to the Stromateidæ. The Tetragonuridæ, though unlike the cycloid Bramidæ of the Scombriformes in form, resemble them, according to Tate Regan, in many significant details of the skeleton.

On the other hand, they present some resemblances to the Mugilidæ near which they were placed by Günther, and Boulenger even places the whole group of families with the Percesoces, thus removing them from all connection with the Scombriformes. The group has apparently descended from some deep-bodied or subcycloid forms resembling the Bramidæ and probably retaining the vertebral formula 10 + 14 which seems to be demanded for the ancestral Acanthopterygians. This low formula is actually very nearly realized in the Black Ruffs or Rudder-fishes, *Centrolophus*, *Palinurichthys* (10 + 14 or 15), the number of vertebræ rising to 30–46 in the remaining Stromateidæ, 58 in the Tetragonuridæ, and, finally, to as many as 70 in *Acrotus* of the Icosteidæ (Jordan '96). In the Tetragonuridæ and Stromateidæ the ventrals when present, have one spine and at most 5 soft rays, as in Percesoces, Scombriformes, and typical Perciformes. As we seem forced to rely on rather trivial but possibly significant characters, the group may be distinguished from the Percesoces

by the presence of but a single long dorsal fin, the spinous portion often much reduced, or else formed of numerous short spines. From the Scombriformes it may be distinguished by the presence of the œsophageal pouches or when these are absent by the gill raker-like knobs below the pseudobranchiæ. The small cycloid scales (when present) of the Stromateidæ, Icosteidæ, resemble those of many Scombriformes and of the Lampridæ, while the scales of the Tetragonuridæ, which are described as hard, bony, adherent, ciliated, and grooved or strongly keeled, may perhaps be compared with the cycloid, heavily ridged or keeled scales of the Bramidæ. The pelvic bones are free from the clavicle in Tetragonuridæ, Icosteidæ, and in some Stromateidæ, in others more closely, but still movably, attached by ligament (Boulenger). On the assumption that this loose attachment is "a primitive character and not the result of specialization, such as occurs in some cases among true Acanthopterygians," Boulenger, as we have said, removes the group from the Scombriformes to the Percesoces. This enables him to improve the technical definition of the Scombriformes, and, furthermore, the Nomeiformes may well be remotely related to the true Percesoces, by inheritance of the typical formulæ of 10 + 14 in the vertebræ and I, 5 in the ventral fins. But this does not seem to lessen the phylogenetic significance of the many resemblances of this group to the Scombriformes. Convergence plus the inheritance of primitive characters hardly seem enough to account for the detailed resemblances between the Butter-fish, *Rhombus* (*Poronotus*) *triacanthus* of the family Stromateidæ and the Common Pampano (*Trachinotus carolinus*) of the family Carangidæ, or the osteological similarities between the Tetragonuridæ and the Bramidæ. If, as Boulenger holds, the families in question cannot be regarded as Scombriformes without rendering it impossible to define that group, then I suggest that they be segregated as a division, Nomeiformes, of the suborder Percomorphi, coördinate with and in the neighborhood of the Scombriformes. If the Upper Cretaceous genera *Omosoma* and *Platycormus* are correctly referred to this group, the Nomeiformes are older than any known Scombroids, and as old as any other known Acanthopterygians.

Superorder ACANTHOPTEROIDEI (?)
(Plate XXIX.)

Order **Hypostomides**[1] *Gill*

The Sea-moths, Pegasidæ, are often regarded as an offshoot of the Stickleback-Sea-horse series, and they indeed resemble different members of that assemblage in general appearance, in the possession of a bony exoskeleton, pectinated gills, reduced gill openings, a single dorsal fin, and in the loss of the preoperculum. But Boulenger[2] admits that the supposed relationship with the Thoracostraci is still somewhat doubtful, Gill assigned the group to a separate suborder Hypostomides of the order Teleocephali, following the suborder Acanthopterygii, and Day[3] regarded *Pegasus* as a widely aberrant member of the Gurnard group, a view which seems favored by the following evidence. *Pegasus* differs from the Thoracostraci in the fact that the greatly enlarged pectorals are not vertical but horizontal, and the mouth instead of being terminal as in the Sea-horses is placed beneath the base of the elongate tubular snout. But these are also points of resemblance to certain of the Agonidæ[3] among the cheek-armored Acanthopterygii, with which there is also a general agreement in the characters and arrangement of the dorsal scutes, of the pectoral dorsal and caudal fins, in the dorsal position of the eyes, great reduction of the rays of the dorsal fins, etc.[3]

Order **Opisthomi**[4] *Gill nec Cope*

The Spiny Eels.
(Plate XXIX.)

These "spiny-finned eels," forming the family Mastacambelidæ, were mistakenly grouped with the pelagic Notacanths (p. 483),

[1] ὑπο, beneath, στῶμα, mouth, in allusion to the position of the mouth below the produced snout.

[2] *Cambridge Natural History*, Vol. VII, p. 629.

[3] Compare the figures of *Pegasus draco* in Day, *Fishes of India* pl. lxi, fig. 1, and *P. natans* in Günther, Introduction, etc., p. 483, with the figures of certain Japanese Agonidæ described by Jordan and Starks in *Proc. Nat. Mus.*, Vol. XXVII, 1904, p. 596, especially *Podothecus thompsoni* (fig. 11).

[4] ὄπισθεν, behind, ὦμος, shoulder, in allusion to the backward displacement of the pectoral arch.

by Cope. They parallel the true Apodes[1] in the anguilliform body, the multiplication of the vertebræ, gephyrocercal tail,[2] loss of the ventral fins, reduction of the scales, and especially in the severance of the pectoral girdle from all connection with the skull, it being far removed from the skull and attached to the vertebral column. The group inhabits brackish and fresh waters of southern Asia and tropical Africa, and parallels the anguilliform Dipnoi, Gymnarchs (p. 470), and Gymnotids of those regions in its mud-loving habits and in the ability to respire air directly. The allocation of this group to the Acanthopteroidei (possibly to the Blenniidæ, Boulenger) is indicated by a number of characters, including the closed condition of the air-bladder, the interjection between the parietals of the supraoccipital, and the contact of the latter with the frontals, the presence of the spines in the vertical fins, the exclusion of the maxillaries from the border of the mouth.

Appendix I.

Independent or homoplastic evolution of the eel-like form of body, illustrated in a list of eel-like vertebrates belonging to different families and orders.

Criteria: anguilliform body with multiplication of vertebræ, gephyrocercal tail, reduced pelvic limbs, usually predatory habits.

SUBCLASS	ORDER, SUBORDER, ETC.	FAMILY OR GENUS	REMARKS.
Cycliæ		*Palæospondylus*	Incompletely anguilliform.
Marsipobranchii	Hyperotreti	Bdellostomidæ	
"	Hyperoarti	Petromyzontidæ	
Elasmobranchii	Diplospondyli	*Chlamydoselachus*	Ventral fins only somewhat reduced.
Dipneusti	Sirenoidei	Lepidosirenidæ	
Teleostomi	Crossopterygii	*Calamoichthys*	
"	Chondrostei[3] (?)	*Belonorhynchus*	Incompletely anguilliform.
	Isospondyli	Stomiatidæ	Tail not gephyrocercal.
"	"	Osteoglossidæ (*Arapaima*)	
"	"	Gymnarchidæ	
"	Heteromi	Notacanthidæ	
"	"	Halosauridæ	
"	Heteromi (?)	Dercetidæ	
"	"	Fierasferidæ	
"	Symbranchii	All (2 families)	
"	Apodes (proper)	All (3 suborders and numerous families)	

[1] See Appendix I.

[2] See Appendix II.

[3] The scarcity of known eel-like forms among the Ganoids is remarkable.

SUBCLASS	ORDER, SUBORDER, ETC.	FAMILY OR GENUS	REMARKS.
Teleostomi	Apodes (?) Carencheli	Derichthyidæ	
"	Apodes Lyomeri	Saccopharyngidæ	
"	Nematognathi	Several genera especially *Clarias*, *Stegophilum*.	
"	Eventognathi	Cobitidæ	Tail not gephyrocercal.
"	Gymnonoti	Gymnotidæ	Eel-like Characins.
	Haplomi	*Neochanna apoda* (Galaxiidæ)	
"	Thoracostraci	Several genera elongate but not strictly anguilliform	
"	Anacanthini	*Enchelyopus* a Gadid	
"	Acanthop. Jugulares	Ammodytidæ	Tail not gephyrocercal.
"	"	Congrogadidæ	
"	"	Blenniidæ *Chænops*, *Xiphasia*, *Cryptacanthus Stathmonotus*, and many others.	
"	"	Ptilichthyidæ	
"	"	Zoarcidæ (*Lycodes*, *Lycenchelys*, and other genera.)	
"	"	Ophidiidæ	
"	"	Atcleopodidæ (Podatelidæ)	
"	"	Brotulidæ (*Bassozetus* and 2 other genera)	
"	Heterosomata	*Symphurus*	(a Soleid, body incompletely elongate, tail gephyrocercal; apodal)
"	Tæniosomi	Trachypteridæ (*Regalecus*)	

ANGUILLIFORM AMPHIBIA, REPTILIA, MAMMALIA.

Amphibia	Stegocephali	Aistopodidæ	(No limbs).
"	Urodela	Amphiumidæ	(Limbs vestigial).
"	Gymnophiona	Cœcilians	(No limbs).
Reptilia	Lacertilia	Anguidæ	(*Ophisaurus*, *Anguis*) (no limbs).
"	Ophidia	*Enhydrina*	(Body compressed, tail eel-like).
"	Rhynchocephalia	*Saurophidium*	(?Aquatic) (Limbs reduced).
"	Pythonomorpha	*Tylosaurus etc.*	(But limbs functional).
"	Crocodilia	*Metriorhynchus*	(But limbs functional)
Mammalia	Archæoceti	*Zeuglodon*	

APPENDIX II.

Evolution of the Caudal Fin. (*Modified from Ryder*[1] *and Dollo*[2])

[1] "On the Origin of Heterocercy and the Evolution of the Fins and Fin-Rays of Fishes." *Rept. U. S. Commission Fish and Fisheries*, 1884, pp. 981–1107. Also in *Am. Naturalist*, 1885, pp. 90–97, 200–204.

[2] "Sur la Phylogénie des Dipneustes," *Bull. Soc. Belgique de Geol.*, tome ix, 1895, pp. 79–128. "Results du Voyage du S. Y. Belgica . . .," *Zoologie*, Poissons, 4to, Anvers, 1904, pp. 234–239.

Stage 1, DIPHYCERCY Notochord straight, opisthure symmetrical and separate from caudal fin.

Examples: *Amphioxus*, *Palæospondylus*, Cyclostomes, certain Chimæroids (*Hariotta*), certain Acanthodians, *Chlamydoselachus*, embryonic sharks, ganoids, and teleosts.

Stage 2, HETEROCERCY Derived from diphycercy by development of the true caudal fin beneath the notochord, the opisthure upturned. The dermal portion may become fan-like (rhipidoid).

Stage 3, HOMOCERCY Derived from heterocercy by progressive upturning and reduction of the opisthure and by the coalescence of the posterior interhæmals into broad "hypurals," which form a fan-shaped (rhipidoid) bony tail. The dermal portion may be fan-like (rhipidoid) or pointed (gephyroid).

Examples: *Clupea, Salmo.*

Stage 4, EUHOMOCERCY (New term) Derived from homocercy by the loss of the opisthure, the reduction of the hypurals and epurals, which are functionally replaced by ossified dermal rays, producing a perfectly symmetrical bony tail.

Examples: mackerel group.

(= Homocercal rhipidocercy Dollo.)

Stage 2′, GEPHYROCERCY Derived from heterocercy by degeneration of the opisthure; the posterior portion of the median superior and inferior fins fuse posteriorly to form a new and symmetrical, pointed tail fin.

Examples: *Polypterus*, *Ceratodus*.

(= Heterocercal gephyrocercy Dollo.)

Stage 3′, HYPOCERCY (new term). Derived from homocercy by coalescence of the fan-like caudal with the prolonged anal, the conjoined inferior fins being then pulled out into a long pointed tail fin.

Example: *Notopterus*, Macrouridæ.

(= Homocercal gephyrocercy Dollo.)

Stage 3′ or 3,″ ISOCERCY Derived from homocercy or hypocercy by the atrophy of the pointed tail and the development of a new fan-shaped tail around the stump of the old one.

Examples: *Gadus*, *Anguilla Simenchelys*.

(= Dorso-caudal rhipidocercy Dollo.)

LEPTOCERCY A condition in which the tail ends in a long delicate wisp, often an adaptation to deep-sea conditions. May be derived from Stages 1, 2, 2′, or 3′.

[ANNALS N. Y. ACAD. SCI., VOL. XVII, No. 4, PART II, pp. 509–518.
August, 1907.]

A PERIDOTITE DIKE IN THE COAL MEASURES OF SOUTHWESTERN PENNSYLVANIA.

BY J. F. KEMP AND J. G. ROSS.

The discovery of dikes and other forms of intrusive rocks in the almost undisturbed Paleozoic strata west of the Appalachian upheavals is a matter of much scientific interest and has been so esteemed in the several announcements which have been hitherto made. The occurrences are all in localities where, under ordinary circumstances, intrusive rocks would not be anticipated, and they tend to make a geologist cautious in inferring the necessary absence of igneous phenomena beneath any region from the mere fact that they do not appear on the surface. By way of introduction to a new occurrence it will be of interest to recapitulate briefly with the accompanying outline map the cases already known.

The first three discoveries were mentioned by Lardner Vanuxem in his report on the Third District of New York in 1842, although one of them, the Syracuse Serpentine, had been noted five years before.[1] The serpentine, however, was not recognized as igneous in its nature, until the microscopic examinations of Professor Geo. H. Williams demonstrated its true character in 1887. Since then other neighboring occurrences have been discovered from time to time and have been described in the citations given below. Speaking in general terms, the rock is a peridotite and penetrates the Onondaga Salt Group. In some more recently afforded material C. H. Smyth, Jr., has identified melilite, and it is possible that this mineral was once

[1] For a full account of this interesting rock and a sketch of its history in the literature see Geo. H. Williams, "On the Serpentine (Peridotite) Occurring in the Onondaga Salt Group at Syracuse, N. Y.," *Amer. Jour. Sci.*, Aug. 1887, p. 137.

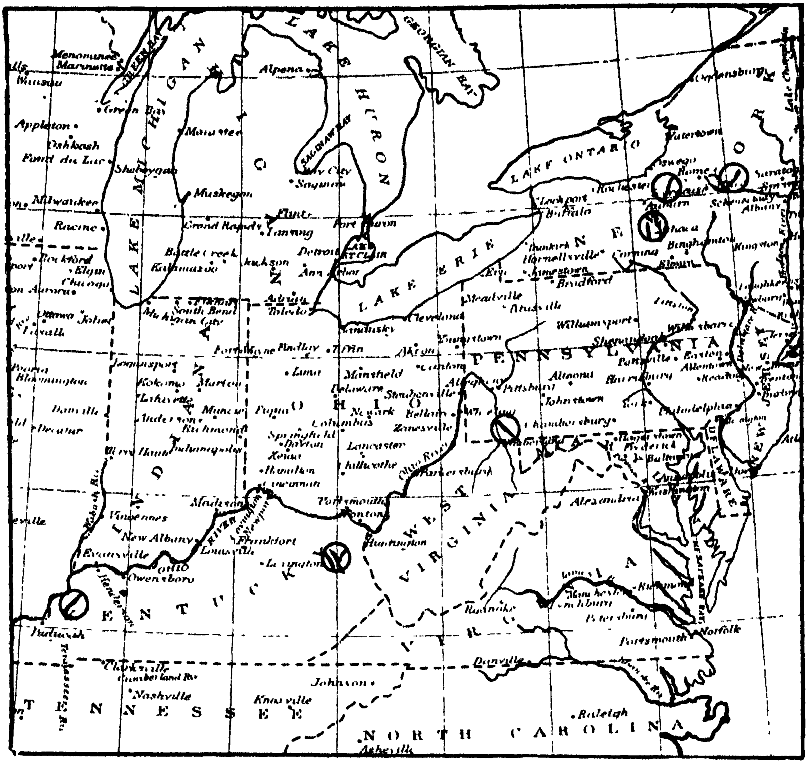

FIGURE 1.

Outline map of known localities of basic dikes from New York to western Kentucky.

of general occurrence, but that it has disappeared in the course of decomposition, to which it is quite sensitive. P. F. Schneider has noted that one of the dikes strikes N. 5° E., and this bearing has been used in plotting the map here employed.[1]

[1] N. H. Darton and J. F. Kemp, "A New Intrusive Rock near Syracuse," *Bull. Geol. Soc. Amer.*, VI, p. 477, 1895. P. F. Schneider, "New Exposures of Eruptive Dikes in Syracuse, N. Y.," *Amer. Jour. Sci.*, July 1902, p. 24. See also *Proc. Onondaga Acad. of Sciences*, I, p. 110, 1903. C. H. Smyth, Jr., "Petrography of the recently discovered dikes at Syracuse, etc.," *Amer. Jour. Sci.*, July 1902, p. 26. E. H. Kraus, "A New Exposure of Serpentine at Syracuse, N. Y.," *Amer. Geologist*, May, 1904, p. 330.

The second record by Vanuxem is that of a dike near Manheim Bridge, on East Canada creek, 75 or 80 miles east of Syracuse. The dike comes up on a well-known fault between the Beekmantown limestone on one side and the Trenton and Utica formations on the other. (See p. 270 of Vanuxem's Report.) The petrography of this and of more recently discovered neighboring dikes has been worked out by C. H. Smyth, Jr., who proves that the rock is the rare and interesting species alnoite, a melilite-basalt. The dike strikes with the fault, which varies from N. 40° E. to N. 20° E., the former bearing being the direction where the dikes are exposed. P. F. Schneider subsequently identified five dikes, all of which cross the creek.[1] This rock is of much interest in connection with the new occurrence here described, even though no melilite has been as yet demonstrable in the latter. Professor Smyth has also worked out some extremely interesting data regarding the amount of weathering since the disappearance of the glacial ice-sheet.

The third occurrence mentioned by Vanuxem is of four narrow dikes near Ludlowville, N. Y., in the Genesee slate (p. 169 of his Report). Ludlowville is about ten miles north of Ithaca on the east side of Cayuga lake, and is approximately fifty miles southwest of Syracuse. As will appear, the region about the southern end of Cayuga lake is another center of fairly numerous outbreaks. The original discovery has since been added to by others in and near Ithaca, and in the largest case of all, in a small ravine, a mile south of Glenwood, a dike, has been reported by V. H. Barnett which is certainly 25 ft. and may be more than 100 ft. in width. These dikes cut the Devonian strata as high up as the Portage. The petrography has been most carefully worked out by G. C. Matson. Olivine and biotite are the chief minerals present, with less abundant diopside, magnetite,

[1] C. H. Smyth, Jr., "A Third Occurrence of Peridotite in Central New York," *Amer. Jour. Sci.*, April 1892, p. 322. "Alnoite Containing an Uncommon Variety of Melilite," *Idem*, August 1893, p. 104 " Weathering of Alnoite at Manheim, N. Y.," *Bull. Geol. Soc. Amer.*, **IX.**, 1897, p. 257. P. F. Schneider, "The Correlation of Some Alnoite Dikes in East Canada Creek, N. Y.," *Science*, Nov. 24, 1895, p. 673. The first dike discovered is illustrated in the cut on p. 247 of Scott's *Introduction to Geology*.

ilmenite, perofskite, picotite, and apatite. Alteration products are also much in evidence, but no melilite was discovered. The dikes strike nearly north and south and are believed by Mr. Matson, from their relations with the gentle folds and faults to have entered near the close of the Paleozoic.[1]

Three interesting bowlders have been found in the drift at Aurora, Canandaigua, and Syracuse, apparently from not remote sources. They are all obviously dike rocks of basic character, and are in quite fresh condition. They are of unusual types, each, however, differing from the dikes which have been found in place. Full descriptions are given in the papers cited below.[2]

In southwestern Pennsylvania, 200 miles from Ithaca, the dike occurs which is shortly to be described in this paper. In Elliott Co., Ky., 200 miles farther to the southwest there occur two dikes less than a mile apart and cutting the Coal Measures. The dikes strike northwest and the eastern one sends off a long prong to the northeast. The longest exposure is a little less than a mile in length, and the greatest width is fifty feet. The rock is a typical peridotite in which olivine is much the most abundant mineral, constituting with the serpentine referable to it, more than half the mass. With it are pyrope, ilmenite, enstatite, biotite, and apatite in decreasing order among the original components, and serpentine, dolomite, magnetite, and perofskite (first determined as octahedrite) among the secondary.[3]

[1] J. F. Kemp, "Peridotite Dikes in the Portage Sandstones near Ithaca, N. Y.," *Amer. Jour. Sci.*, Nov., 1891, p. 410. In this paper several earlier local records are mentioned. P. F. Schneider, "Notes on Eruptive Dikes near Ithaca, N. Y.," *Proc. Onondaga Acad. Sci.*, I, 130, p. 1903 V. H. Barnett, "Notice of the Discovery of a New Dike at Ithaca, N. Y.," *Amer. Jour. Sci.*, March, 1905, p. 210. G. C. Matson, "Peridotite Dikes near Ithaca, N. Y.," *Jour. Geol.*, April-May, 1905, p. 264.

[2] J. F. Kemp, "A Remarkable Erratic from Aurora, N. Y.," *Trans. N. Y. Acad. Sci.*, XI, 1892, p. 126. B. K. Emerson, "Notes upon Two Boulders of very Basic Eruptive Rock from the West Shore of Canandaigua Lake, etc.," *Am. Rep. N. Y. State Mus.*, **46**, p. 251, 1893. This eruptive had a piece of Trenton limestone adhering to it and showing contact effects. C. H. Smyth, Jr., "On the Syracuse bowlder," *Amer. Jour. Sci.*, July, 1902, p. 30.

[3] J. S. Diller, "Peridotite of Elliott Co., Ky.," *Bull. U. S. Geol. Survey*,

Some 275 miles west of the Elliott Co. exposure there is a similar dike in Crittenden Co., Ky. It appears in a fault, which has the St. Louis beds of the Lower Carboniferous on the northwest and the Upper Chester and Coal Measure beds on the southeast. It strikes N. 44° E., is known over a stretch of six miles, and is more than 20 ft. wide at one place. At least one other dike has been discovered in the same section. The rock is a mica-peridotite, 75 per cent. of the mass being biotite and serpentine from olivine. Perofskite, magnetite, chlorite, and calcite make up the remainder. Some fluorspar deposits are associated with the dike.[1]

More than 300 miles southwest of the last-named exposure is found the peridotite of Pike Co., Ark. This again is a biotite-bearing peridotite with augite, perofskite, and magnetite. It certainly cuts both Carboniferous and early Cretaceous strata and is believed to have entered at the close of the Cretaceous.[2] In central Arkansas there are numerous basic dikes outside the area of nephelite-syenite which are of peculiar mineralogical composition. They are rich in biotite and augite but lack olivine. No melilite could be identified.[3]

Leaving for the moment this review of earlier records, the reader may now follow the details of the Pennsylvania occurrence, after which some general comparisons may be drawn.

The dike which furnishes the special subject for the present paper lies in southwestern Pennsylvania about thirteen miles north of the West Virginia state line. It was first noted more than forty years ago, by Mr. Alexis H. Ross, a local resident, but it seems not to have become known to any geologist. In the last few years during which coal mines have been developed

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38, 1887. Some interest has been excited in the possible discovery of diamonds in this dike, and the same idea has been current with regard to the Syracuse dike.

[1] J S. Diller, "Mica-peridotite from Kentucky," *Amer. Jour. Sci*, Oct. 1892, p. 286.

[2] J. C. Branner, "Peridotite of Pike Co., Ark," *Amer. Jour. Sci.*, July 1889, p. 50. *Rept. Geol. Surv. Ark*, II, p. 377, 1890.

[3] J. F. Kemp, "Basic Dikes Outside the Syenite Areas of Arkansas," *Rept. Geol. Surv. Ark.*, II, p. 392, 1890.

it has been found underground, and thus the best exposures and the freshest rock have been obtained. Specimens were handed to the senior writer in the fall of 1905 by J. G. Ross, the son of Alexis H. Ross, and at the time Fellow in Mining in Columbia University. The dike was announced and briefly described before the Geological Society of America at the Ottawa meeting December, 1905, and since then additional specimens have been studied and an analysis has been prepared. The extent and location of the dike have been worked out in detail by J. G. Ross and his brother Donald.

The dike is in the Masontown quadrangle and on the east bank of the Monongahela River. It cuts across one of the small tributaries of the Monongahela called Middle Run, at whose mouth is the coal-mining town of Gates. To the southeast it has been found as far as the little town of Edenborn, where, in the coal mines of the Frick Coal Company, it pinches out, after forming three separate branches. To the northwest, it appears in the highway along the east bank of the Monongahela, but efforts to find it on the west bank have not been successful. The details of situation are shown in Fig. 2.

The local geology is shown in detail in the Masontown-Uniontown folio, No. 82, of the U. S. Geological Survey. The Monongahela series is exposed along the river bank with the Pittsburg seam, at the mouth of Middle Run, 240 ft. below the river. The Monongahela series is 380 ft. thick at this point, so that the Waynesburg seam is 140 ft. above the river Still higher the Dunkard series covers the hill-tops. The dike certainly cuts the Waynesburg seam and rises at least 20 feet higher in the overlying Dunkard series.

On the surface the dike is narrow wherever discovered and is single, except at the crossing of Middle Run. The observed thicknesses vary from about one foot to about 3 feet, except in the Waynesburg coal where it is 10 feet. Under ground, however, where the opportunities for exact study are better, the thickness at the horizon of the Pittsburg seam reaches a reported maximum of 35 feet. The dike moreover is known to split up. At the southeast, as it runs out, there are three narrow branches, each a few inches across. At the extreme northwest there are

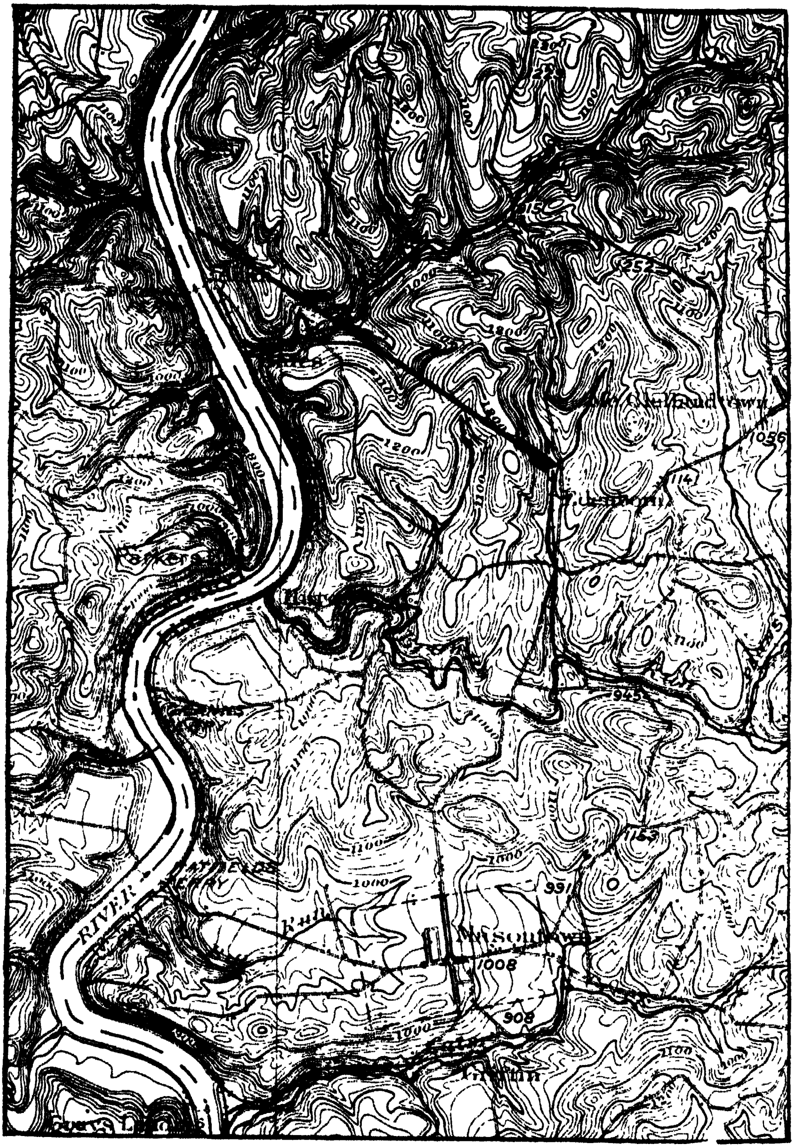

FIGURE 2.

The dike in Fayette Co., Penn. The line from Edenborn to Adah represents the dike. Scale 1 inch = 1 mile.

two, one of which is three inches wide, the other many feet. The latter makes as clean cut a diaphragm with respect to the heading as would a stone flag set on edge. At a point about one-third its length to the southeast, there are again two parts above ground. Apparently as the dike rose from the depths toward the surface, it sent off stringers, or itself forked into two or more parts. At the Pittsburg seam it expanded to its greatest known width. At the same time it coked the coal, and its effects may be detected for fifty feet on each side in the seam. At the edges of the dike the coked coal has often become involved in the igneous rock, which, itself, is finer grained from the chill.

On the outcrop, the rock is weathered and nearly brown. It breaks in spheroidal masses which are very tough and hard to fracture. Where freshest in the mines it is blackish gray and decidedly porphyritic. The phenocrysts may reach two or three centimeters in diameter and are chiefly a pale green mineral breaking along an even but not perfectly smooth surface. Small phenocrysts of the reddish brown biotite characteristic of the basic rocks may be detected with the eye, and quite large but rounded masses of magnetite are scantily set in the matrix. In its finer texture the rock has a granular aspect due to the predominant but rounded grains of some mineral not recognizable with the unaided eye.

Under the microscope the rock is found to be much altered in all specimens, but in the freshest the original minerals can be determined or inferred with much certainty. As in the other similar cases biotite has resisted weathering much the best of all, and its brownish yellow crystals seem in many cases slightly if at all affected. It varies in size from small plates 0.1 mm. in diameter up to crystals two or three millimeters across. It is strongly pleochroic, golden-brown to colorless, and has a visible but small angle between the optic axes.

Olivine is the most abundant component, but it has become altered almost beyond recognition in nearly all cases. Its outward shape, however, is characteristic, and in several instances fresh nuclei have been detected which gave a positive result, when optically tested. The olivine is itself so nearly colorless, and its

alteration products are themselves in almost all cases so pale in tint that one would expect a molecule near forsterite. In but two slides were its secondary minerals noticeably green, and then they were undoubtedly chlorite. The alteration has gone so far or has taken such a course as not to show serpentine veinlets in marked development, but by careful search both fibrous chrysotile and scaly antigorite have been detected. The identity of the olivine is in consequence a little less apparent than is often the case. Abnormally large and corroded or rounded phenocrysts of olivine are also present up to two or three cm. in diameter, as was mentioned above. They are altered like the rest but have fresh nuclei. To the unaided eye, they resemble pyroxene more than olivine.

Magnetite is quite richly distributed, and the grains may reach a size several millimeters in diameter. Much of it is shown by the alteration product to be titaniferous. Perofskite is abundant in small, highly refracting, brown grains. Apatite is present. One garnet with a kelyphite rim has been detected, and pyrite is occasional. Almost all accurate traces of the ground mass, whatever it was, have given way to calcite and dolomite, which are richly present in the slides. Careful search has failed to reveal the melilite which one would suspect to be present, from the abundant calcite in the rock, nor can any other feldspathic mineral be identified. In one instance isotropic material was found, which was perhaps analcite, and through it was distributed very small stocky prisms which may once have been angites

An analysis kindly made by Miss M. W. Adams yielded the following results:

SiO_2	28.83%	Na_2O	.75
TiO_2	5.07	K_2O	1.31
Al_2O_3	2.94	H_2O+	3.96
Fe_2O_3	3.60	H_2O-	0.83
FeO	5.13	CO_2	11.64
MgO	24.31	P_2O_5	0.77
CaO	11.24	*Total*	100.98

It is possible to recast this analysis only in an approximate way, but by several assumptions a result can be reached which

is probably not far from the truth. In order to separate the biotite, it is assumed that its composition is similar to the analysis given in Rosenbusch's *Elemente der Gesteine*, p. 234, for one from a monchiquite (which analysis is quoted in the *Classification of Igneous Rocks*, Table XIV.) On this basis the results are as follows:

Biotite	20.89%
Olivine	6.30
Serpentine	29.25
Perofskite	2.31
Ilmenite	6.38
Magnetite	2.09
Apatite	1.68
Analcite	1.58
Calcite	16.60
Magnesite	8.23
Quartz	4.98
Total	100.29
Water	0.83
Grand Total	101.12

It is evident that some very rich calcium-bearing mineral must have contributed the calcite. Anorthite, diopside, and melilite will at once suggest themselves. Anorthite is out of the question, because the alumina fails. If diopside or some other monoclinic pyroxene had been once in the rock, we ought to see the outlines of its crystals still remaining. Melilite is the most probable, but if it were once present, its destruction has been very thorough. A richly calciferous glass or basis seems to be the only possible further assumption.

In conclusion acknowledgments are due to Drs. C. P. Berkey and A. A. Julien for assistance regarding some puzzling features of the microscopic mineralogy; to Miss Adams for the analysis, and to Donald Ross for aid in the field.

[ANNALS N. Y. ACAD. SCI., VOL. XVII, NO. 5, PART II, pp. 519–562, PLL. XXXI and XXXII. Published September 10, 1907.]

A CONTRIBUTION TO THE GEOLOGY OF SOUTHERN MAINE.

By I. H. OGILVIE, PH.D.

INTRODUCTION.

The aim of this paper is to set forth the salient features of the geology of a small area in southern Maine from the points of view of physiography, chemico-mineralogical petrology and metamorphism, respectively. On the petrological side, the igneous rocks are those especially considered, and all questions of structure or stratigraphy among the sedimentary schists are omitted.

The area discussed comprises that part of the Boothbay quadrangle which lies between the Sheepscot and the Damariscotta river. The region is one of the typical examples of a fiord coast, while its rocks are a metamorphic complex of schists and gneisses, together with dike and plutonic igneous rocks ranging in composition from aplite to dunite. The purpose of the map is to illustrate the rock types described. It is not intended as a complete geological map of the region.

The field work was done during the summer of 1905, the writer being assisted by K. I. Cook and M. W. Adams. Microscopical and chemical work has been carried on during the past two winters in the laboratories of Columbia University. Prof. A. W. Grabau of Columbia University had previously visited the region with a summer field class from the Teachers' School of Science of the Boston Society of Natural History, and he kindly placed his specimens and notes at the writer's disposal. The map of Cabbage Island (Fig. 1.) was worked out by this class, and the diabase dikes on Linekin's Bay were found by him. Most of the rock types of the region were included in Dr.

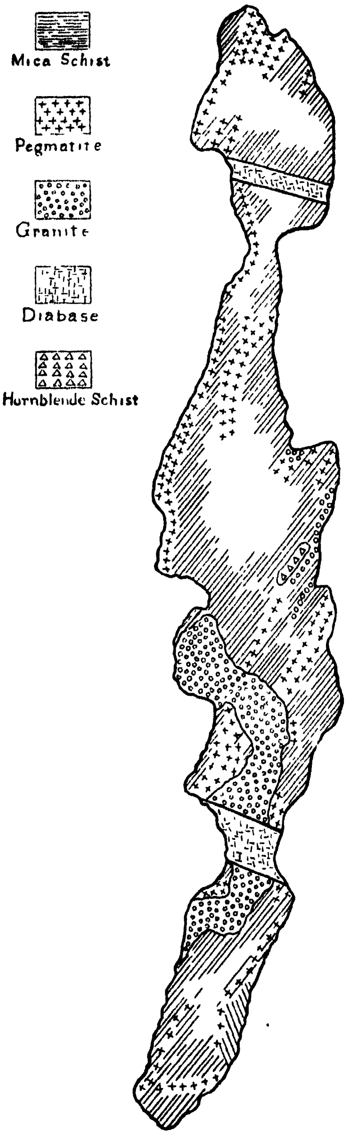

FIG. 1.
Geological map of Cabbage Island, Maine.

Grabau's collection, and especial thanks are due to him for this material.

The chemical analyses were done by M. W. Adams, to whom the writer is greatly indebted. The methods followed were those recommended by Washington in his book *The Chemical Analysis of Rocks*. The most important oxides were determined in each case, including both oxides of iron, titanium and phosphorus. The Lawrence Smith method was used for the alkalies; the colorimetric method for titanium, and ammonia for the precipitation of alumina, manganese being neglected. The bluish-green cake after the first fusion indicated that manganese was present in nearly every case. In the one rock (a diabase) in which it appeared to be greatest in amount, it was determined on a separate portion and found to be 0.35%. The aim of the analyst was to produce analyses that should be "superior" in the sense of being accurate, but which should be inclusive of the rarer oxides only in so far as the interest and importance of the region seemed to warrant.

There is no recent literature dealing with the area here described. Diabase dikes from the eastern part of the Boothbay

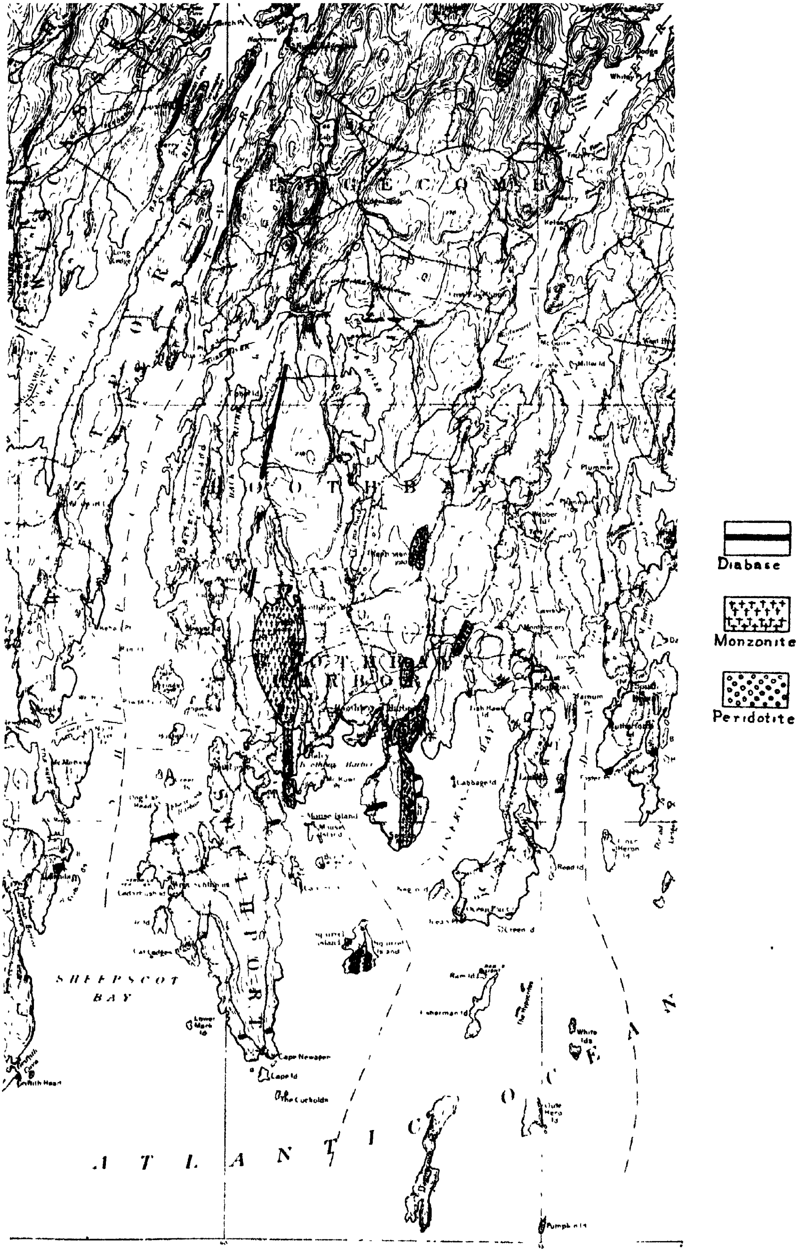

FIG. 2.
Partial geological map of part of the Boothbay Quadrangle, Maine

quadrangle were described by F. Bascom,[1] and these are inserted on the map (Fig. 2). Only the westernmost exposure of these dikes was examined by us. It was at first thought that Dr. Bascom's big dike might be the same rock-body as one of the dikes of Cabbage Island and the neighboring mainland, but repeated surveys across Linekin's Neck showed that, unless there is displacement by faulting, there are without doubt three parallel dikes.

The only other literature dealing with the area is comprised in the reports of C. H. Hitchcock. Of neighboring localities Monhegan Island about twelve miles to the southeast has been described,[2] and in Knox County, about fifty miles to the northeast some interesting rock types have recently been studied.[3]

PHYSIOGRAPHY.

The topography of the Boothbay quadrangle is characterized by an alignment of ridges and depressions in a direction which changes from due north and south in the southern portion to N. 20° E. in the northern. That is to say, each ridge and valley describes a curve. Tide-water enters all of the larger valleys and extends beyond the northern boundary of the quadrangle. The tides rush up and down these narrow inlets with great force and undoubtedly have great erosive power. Many tributaries enter the main valleys at abnormal angles, and the branches of the tributaries sometimes enter at abnormal angles, also, so that it is not uncommon for a single stream course to describe three sides of a square.

It is found that the major features which have produced the adjustment are the strike and the joints of the rock. The principal valleys are outlined by the strike, which has a general north and south trend; the tributaries are adjusted to the joints,

[1] "Dikes in the Vicinity of John's Bay, Maine," *Amer. Geol.*, XXIII, 1899, pp. 275–280.

[2] "Notes on the Geology and Petrology of Monhegan Island, Maine," by E. C. E. Lord, *Amer. Geol.*, XXVI, 1900, p. 329.

[3] "Some Unusual Rocks from Maine," by Edson S. Bastin, *Jour. Geol.*, XIV, 1906 p. 173.

of which the major ones have a N. 85° E. direction. Dikes follow some of the joints.

The oldest rocks of the region are mica schists, which are soft and easily eroded. Intruded into these are granitic rocks of various types, which are hard. The metamorphism which occasioned the schistosity followed the intrusion of the igneous rocks, and the present adjustment of streams is in part to the direction of the strike of the bands of soft rock, in part to the direction of the fissility. There has probably been some folding also.

Faulting on a small scale is frequent. Plate XXXI, Fig. 1 shows a small example of "Graben" on Negro Island. There are many such, the faults being usually of the gravity type. Whether there has been faulting on a larger scale, it is impossible to say; but the fact that the eastern shore of the promontories is invariably steep, while the western has a gentle slope is suggestive.

The drainage is well adjusted, and the only notable pre-glacial interruptions to the erosion cycle have been movements of elevation and depression. Evidence of elevation is to be seen in wave-cut cliffs and gorges, but these are at no great height above the present level of the sea. If any such great subsidence took place as has been described by Shaler in Mount Desert[1] it was of too rapid a nature for shore features to be developed. A single marine beach is to be seen on the north side of a hill east of Boothbay Harbor at an altitude of about 100 feet.

The diabase dikes produce notable topographic features. The dikes are harder than the surrounding schists, and in the interior of the country away from the sea, they stand up as conspicuous ridges. The dikes have a columnar parting which is either horizontal or slightly inclined. When within reach of the waves this columnar structure affords opportunity for wave action, and the dike thus attacked is worn away more rapidly than the surrounding rock, thus producing a chasm. These two contrasting topographic effects are illustrated in Plate XXXI, Fig. 2, and Plate XXXII, Figs. 1 and 2.

The altitude of the highest hills is of moderate uniformity; it varies from 200 to 290 feet above sea. This level apparently

[1] *Annual Rept., U. S. G. S.*, VIII, Pt II.

does not represent a pene-plain, but is occasioned solely by the attitude and resistance of the hardest rocks—the granites. The softest rocks are the schists. These determine the course of the rivers, and are near sea level, while the more basic igneous rocks usually outcrop at intermediate altitudes. The elevations of intermediate hardness form knolls about 130 feet high.

There are no conspicuous glacial features. The drift is thin and consists mainly of scattered bowlders. If any physiographic work was done by the ice it was of the nature of excavation. There are no deposits of sufficient extent to cause any changes in drainage. Such lakes as exist are wholly or in part artificial. Striæ were found at the following localities and in the following directions. The direction of ice motion was evidently nearly southward.

Table I.

Glacial Striæ.

Locality.	Direction.	Rock.	Position on Map[1]
North end Adams Pond	N.–S.	Schist	30.4.3
West side Linekin's Bay on northern dike	N. 10° W.	Diabase	54.3.3.
Beside road 3½ miles south of North Edgecomb	N. 10° E.	Gneiss	13.3.4
Beside road 1 mile south of Edgecomb	N. 5° E.	Gneiss	14.7.3.
Same road 1 mile farther south	N. 5° E.	Gneiss	24.1 5.

The fiord character of the coast of Maine is usually ascribed to combined drowning and excavation by ice. The Boothbay quadrangle offers no new evidence on these points. It is clearly drowned, and ice excavation seems very probable; but there is one feature that this history does not explain, and that is the remarkable courses of the streams. As already mentioned it is by no means uncommon for a stream to begin by flowing north, to turn at right angles, and then after a short east or west course to enter one of the southward draining estuaries. The most conspicuous example is afforded by Adams Pond, Back River, Oven Mouth and the lower Back River. Adams Pond is

[1] The figures in this column indicate the position on the map in the manner described by Kemp, *Bull. Geol. Soc. Am.* XVI, p. 411.

artificial. It was thought that possibly there might have been a reversal of drainage brought about by glacial agencies, the Back River and Adams Pond valley having formerly drained southward. This seems clearly not to have been the case. There is more or less sand about the southern end and sides of Adams Pond, but nothing resembling a moraine and nothing in the way of drift that could possibly have blocked a stream. The valley widens northward and has every appearance of being a normal erosion valley developed with the drainage in its present direction. That it is pre-Glacial is evidenced by the presence of both material and striæ. The east-and-west Oven Mouth on the other hand is a very narrow cut with precipitous sides. Three tributaries enter it, two from the south and one from the north, and the tributaries have a much older topographic expression than the Oven Mouth itself. This is clearly due to the fact that the tributaries are developed along the strike and have advantageous courses, while the Oven Mouth is on a joint and cuts across hard layers. There seems no reason to doubt that these tributaries originated after the Oven Mouth, the latter being for practical physiographic purposes, the ocean, and the streams developing as similar streams might arise on an island. But the relation of the larger Back River valley to the Oven Mouth is not so clear. It might have been developed like the tributaries as a normal river valley subsequently drowned, but since the Back River is pre-Glacial, on this supposition the Oven Mouth would of necessity be pre-Glacial too, and the latter is a very steep-sided gorge. It would seem that this and the many similar streams in Maine must date their origin from a time when the slope of the land was somewhat different from what it is at present. The entire surface must actually have been higher than at present, but with relative depression towards the north. The recent drowning has led to the connection of these various valleys by way of much younger tributaries along the joints.

Sea cliffs are notable features of the present erosion cycle. These present interesting variations with respect to the kind of rock involved and the direction of the structure. The granite and the schist each has its particular topographic expression,

and the direction of the cliff with respect to the strike has its effect upon the form of the resulting headland.

Petrology.

It was the aim of the present investigation to deal only with those rocks which are of igneous origin, whether metamorphic or not. A considerable complex of schists and gneisses which appear to be of sedimentary origin was therefore left untouched. Some of the types are distinctly doubtful in origin, and it is quite possible that future research may add to the number of igneous members. The probable sediments are clearly the oldest components of the complex. By far the commonest of these older and doubtful rocks is a sandy mica schist, of decidedly sedimentary aspect. Realizing the uncertainty of the evidence of its sedimentary origin, and because of its very wide-spread occurrence throughout the coast region of Maine, it was thought that an analysis would be of interest. The analysis (Table II) bears out the sedimentary hypothesis. The silica is higher than in any of the igneous rocks of the region, though not excessive for a granite. Lime, iron and magnesia are nearly equal in amount, all being about 4%; the magnesia is relatively too high for an ordinary granite; the sum of the alkalis is too low. Though by no means conclusive the balance of chemical evidence points towards a sedimentary origin; the same is true of microscopic, and of field details.

Table II.

Duplicate Analyses of Mica Schist (Probably of Sedimentary Origin) from Spruce Point, Boothbay, Maine, by M. W. Adams.

SiO_2	71.28%	71.60%
Al_2O_3	12.17	12 38
Fe_2O_3	.62	.53
FeO	3 64	3.64
MgO	3.27	3.31
CaO	4.07	3.95
Na_2O	2.79	2.46
K_2O	1.86	1.89
H_2O+	.31	.31
H_2O-	.09	.09
CO_2	none	none
TiO_2	1.15	1.08
P_2O_5	.20	.20
Total	101 77	101.12

It is thought to be in the interest of accuracy to publish these duplicate analyses precisely as they were made. A better summation would have been obtained by making a composite of the two.

Microscopically the rock is characterized by shreds of biotite with parallel orientation, giving a typical schistose structure. Quartz, orthoclase, a plagioclase near the albite end of the series, brown hornblende and a very little augite make up the rest of the rock, with a little accessory magnetite and apatite. The pyroxene is of the common augite variety, slightly violet tinted from titanium; it is usually twinned, but with no crystal boundaries. The whole is much strained, the feldspars being cracked with minute fissures all parallel to each other, the cracks being filled with sericite. The quartz is decidedly granular.

A specimen from Rutherford Island, given to the writer by Dr. Bascom, is evidently of the same type of rock, but in thin section contains a larger proportion of ferro-magnesian constituents and among these a larger proportion of brown hornblende.

The balance of evidence is that these schists are completely recrystallized, highly metamorphic sediments, originally of the composition of arkose. The presence of the augite is the strongest point against this origin.

Turning to the igneous rocks, there is evidence of at least two periods of intrusion. The first of these antedated the metamorphism of the region. In the field these appeared to present all variations in composition, grading from extreme basicity to extreme acidity. Granite-gneiss, diorite, anorthosite, monzonite, gabbro, hornblende schist and peridotite are a few of the varieties. Analysis reveals the fact that these are not so widely separated as they appeared, and that the majority belong among the intermediate types. Cutting the above-mentioned rocks are numerous less metamorphosed pegmatites and aplites which were not studied by us in detail.

Of later age is a series of diabase dikes. These follow joint planes for the most part and belong to two series, one trending N. 85° E. the other N. 10° E. The physiographic effect of these dikes has already been mentioned.

The classification adopted is the quantitative one recently

proposed.[1] The following table includes the types found on the Boothbay quadrangle, whose description follows.

TABLE III.

Summary of Rock Types Found on the Boothbay Quadrangle.

Class	Order.	Rang.	Subrang.	Old Name.
I. Persalane.	4. Britannare.	2. Toscanase	4. Lassenose	Granite
II. Dosalane.	3. Hispanare.	3. Almerase.	4. Sitkose.	Quartz-augite diorite.
	4. Austrare.	3. Tonalase.	4. Tonalose.	Quartz-mica diorite.
			5. Placerose.	Diabase.
	5, Germanare	1. Umptekase.	4. Umptekose.	Monzonite, gabbro and anorthosite.
		2. Monzonase.	3. Monzonose.	
		3. Andase.	2. Lincolnose.[2]	
III. Salfemane.	5. Gallare.	2. Kilauase	2 Prowersose.	Schist.
		4. Auvergnase	3 Auvergnose.	Diabase and Hornblende schist.
V. Perfemane.	1. Maorare.	1. Dunase	1 Dunose	Peridotite (dunite)

In the following pages the rocks will be discussed under two groups according to age. In one of these groups fall the more or less metamorphosed rocks of all compositions; in the other the younger rocks which according to the old nomenclature would have been called diabases. The great scientific value of the new system of classification becomes evident in a region such as the one under discussion, where two series of rocks differing in age, megascopic and microscopic characters are found to be closely related in quantitative chemical characters and in the possible (but not actual) proportions of certain "standard" minerals.

The authors of the new system expressly state that metamorphic rocks are excluded from their scheme. Nevertheless, in the following pages the system is applied to metamorphic rocks with great significance. It is of course evident that the system is not applicable in cases where there is any doubt of the igneous origin, or in cases where either weathering or percolating solutions have so altered the rock that its original character cannot be determined. In the types in question it was always possible to determine what the original was. The

[1] Cross, Iddings, Pirsson, Washington, *Jour. Geol.*, X, 1902.

[2] New name proposed in this paper.

metamorphism was mainly of the nature of intense crushing, without chemical addition or subtraction. In most cases there were occasional less altered patches, where the original texture and mineralogy could at least be inferred, if not actually observed. It was found that the rocks were invariably originally holocrystalline, usually of granitic texture. The authors of the new system propose various prefixes for the description of texture. These are used in the following pages when the original texture could be observed. When a rock is thoroughly schistose or gneissic the prefix "meta" is employed. Where it is metamorphic, but shows indications of what the texture was before metamorphism, the prefix "meta" is used and also a textural prefix. Thus, "meta-grano-sitkose" is a metamorphic rock in which a former granitic texture is evident, while "meta-auvergnose," is a hornblende schist in which all trace of original texture is lost. In those cases where both metamorphic and non-metamorphic portions were found, the metamorphism is ignored in the nomenclature.

Only one rock in the region was seriously altered by weathering. This was the most basic of the types, being an almost pure olivine rock. It contains serpentine and other alteration products, and in the analysis a notable amount of water and of carbon dioxide was determined. The analysis as a whole could not be recast in terms of the new system because of these extraneous substances. Nevertheless it was perfectly possible to classify the rock, since the alteration products were found on microscopic examination to be all replacements of the olivine. The composition of the olivine could be determined from the analysis, and the alteration products could be ignored in classifying. The only possible chance for error in such a case lies in the doubt about the original proportions between olivine and magnetite, but the mathematical grouping is sufficiently broad for classification to be made in this respect with reasonable certainty.

The tedious labor involved in the production of "superior" analyses necessarily limits the number of them. In this case all of the principal types were analyzed, but many subordinate variations were of necessity examined only microscopically.

The petrographic descriptions of the various types which were not analyzed are given in each case after the discussion of the similar type which was analyzed. It is however realized that there may be errors in the inferred relationships and quantitative development of these unanalysed types. The accurate mathematical estimation of quantities of minerals seen under the microscope is not without difficulty, and is apt to be inaccurate where there are variations in coarseness of grain and where there is a gneissic arrangement of minerals in bands. The problem too becomes the more involved, when the majority of the minerals present are not the ones on which the classification is based. With full regard for the uncertainties involved, calculations were made and the unanalyzed rocks placed with their nearest analyzed allies. In spite of the manifold possibilities of error, it is confidently believed that only by such estimations will the real significance of the metamorphic rocks be appreciated. For example, a dark hornblende schist, consisting mainly of hornblende and plagioclase would in the old system have been reckoned with the gabbros. If any proportions were recorded at all, merely the ratio between hornblende and feldspar would have been noted. In the light of the new system it becomes evident that that ratio has no significance at all, except as regards metamorphism, and the essential and significant conception of the type involves the splitting up of the hornblende into anorthite, diopside and hypersthene molecules which possibly never existed as minerals in the rock, and whose ratios may show more acid affinity than would be supposed on casual inspection. It is not possible to do this without any analysis of the rock, but given one good analysis of a type, it is possible to consider slightly dissimilar types by means of microscopical inspection only.

The acid rocks were the ones which received least attention from us. These were very common and in no way notable, and did not seem of sufficient importance to justify any great expenditure of time on either mapping or analysis. The types will be taken up proceeding from acid to basic within each of the two series. It is, however, to be borne in mind that the acid types are very much the most common.

THE PERSALANES.

Grano-Lassenose. I. 4. 2. 4. (Granite.) *Occurrence.*—This type was found in the form of dikes on Damariscove Island. There were many of the dikes, some running with the strike, some cutting across it at various angles. There was considerable variation in coarseness of grain, and the borders of the dikes were often pegmatitic. The schist was much contorted near the contact and was full of quartz lenses. In fact the whole island was thoroughly injected. Time did not allow of detailed mapping of these dikes. Specimens were collected of all that were found and slides were studied. All of the dikes appeared to be of essentially the same type, so one analysis only was made of them.

TABLE IV.

Chemical Composition and Classification of Damariscove Lassenose.

		Molecular Proportions.	Norm.	
SiO_2	67.59	1.126	Qu	19.56
Al_2O_3	17.41	.171	Or	15.59
Fe_2O_3	.15	.009	Ab	41.39
FeO	2.98	.040	An	14.18
MgO	1 40	.035	Cor	1.33
CaO	3 05	054	Hyp	6.27
Na_2O	4 89	.079	Mag	2.09
K_2O	2.59	.028	Ilm	1.52
H_2O+	.18		Ap	.34
H_2O-	04			
CO_2	none			
TiO_2	.83	.010		
P_2O_5	.19	.001		
Total	101.30			

On consulting Washington's tables[1] it becomes evident that lassenose is one of the commonest of rock types, hence a comparison with other regions would be futile.

Microscopic characters.—Microscopically the dikes are found to be essentially alike, differing mainly in coarseness of grain. They contain biotite, brown hornblende, a very little augite,

[1] Prof. Paper, 14., U. S. G. S.

orthoclase, albite, oligoclase, titanite, apatite and quartz. In some cases the dikes were but little metamorphosed, in others they were intensely sheared, and there are all the intermediate degrees of change. In the crushed varieties there is a pale biotite poor in iron, associated at times with ordinary deep brown biotite, at times with the orthoclase. The light biotite is apparently secondary, of deep-seated or metamorphic origin. Frequently the shreds of the secondary biotite are strung out in lines having parallel orientation, giving the rock somewhat of a schistose structure. In the crushed varieties microcline is common, as are undulatory extinction in the quartz, microperthitic intergrowths and some granulation. A few crystals of zoisite were to be seen, apparently derived from the plagioclase as a product of dynamic metamorphism. Reaction rims are frequent between the biotite and the hornblende. It is very common to see a hornblende individual with deeply corroded edges surrounded by a radiating mass of biotite leaves interspersed with feldspar and dotted with magnetite, the whole enclosed in a biotite individual.

The feldspars, particularly orthoclase, contain inclusions of a fine reddish black dust. Some mica is also present as inclusions. The dust is to be seen especially in the central zones, the edges being free from it. This type of inclusion is present in all the rocks of the region. For reasons that will be discussed later (see p. 538) these are thought to be titaniferous, and to consist of several minerals notably perofskite, rutile,titanite and magnetite.

Norm and Mode.—Plagioclase was the commonest mineral; next in abundance, biotite and orthoclase in about equal amounts, hornblende, augite and zoisite were in small amounts. It appears that the norm agrees fairly well with the mode. The disagreements are that there is no anorthite (all the plagioclase being near the albite end of the series) and no corundum, and that the actual percentage of orthoclase is less than the normative. All of these discrepancies are accounted for by the presence of biotite, hornblende, augite and zoisite. These minerals are too variable to admit of accurate recalculation, but it is evident that some potash is in the biotite, and lime in the other three with alumina distributed among them.

Related Types.—On the mainland and neighboring islands are many granitic dikes and bathyliths. Microscopic examination of many of these revealed mineralogical similarity to the type just described, but with some variation between the proportions of constituents. An estimation of these constituents in terms of standard minerals reveals the fact that class and order are evidently the same as for the type just described, but that there is some variation in the relative amounts of alkalies and of lime. The commonest types from the mainland appear to fall into I. 4. 3. 4, yellowstoneose, no analyses of which were made.

THE DOSALANES.

Meta-grano-sitkose. II. 3. 3. 4. (Quartz-augite-Diorite; Actinolite Schist.) *Occurrence.*—The rock thus classified is one of the most remarkable of the whole region. It forms dikes on Fisherman's Island in a country rock of sandy biotite schist. The dikes frequently parallel the structure, and, as they weather into a gray sand and frequently contain inclusions of the schist, they appear deceptively like a sedimentary rock. They are however found unmistakably cutting the bedding at various angles.

Megascopic Character.—In a fresh hand specimen the igneous nature of the rock is unmistakable. Pink with green spots is its general appearance. The texture is moderately coarse to fine. Actinolite and a schistose structure develop in the crushed parts.

Microscopic Character.—In the less crushed varieties the following minerals were observed, in order of abundance: a greenish augite, quartz, plagioclase (albite and oligoclase), zoisite, brown hornblende, titanite, biotite, apatite. In the more crushed varieties actinolite develops almost to the exclusion of the other ferro-magnesian minerals, while there is a marked increase in zoisite; microcline is abundant, and the quartz is completely crushed.

Similar Types.—The rock just described is confined to the general vicinity of Fisherman's Island. On Ocean Point are a few dikes which may be of the same rock, but the actinolite is not conspicuous in them. The dikes on Ocean Point are like most of the dikes of the region in cutting their enclosing rock sharply, in which respect they differ from the sitkose just described.

The latter develop very conspicuous contact zones of actinolite along the borders. The dikes are all small, usually three inches or less in width, and they are not of great length. On the same island are many large granitic dikes, microscopically similar to the lassenose, which are thirty feet or more in width. These granite dikes are entirely distinct from the sitkose. Megascopically the latter seems to contain primarily pink feldspar and actinolite.

Comparison with Alaskan Sitkose.—It is worthy of note that in the only other known locality where this subrang is found, namely in the neighborhood of Sitka, Alaska, the field relations are described[1] as being essentially similar to those above indicated for Fisherman's Island. In both cases the dike rock is involved with sediments in a way that seems deceptively like bedding, and in both there is a crushing of the quartz on a microscopic scale. The essential differences between the two are the much higher lime content of the Maine rock and the dynamic metamorphism of the whole Maine region at a time subsequent to the intrusion of the dike. The analysis of the Sitka rock is here reproduced for comparison.

TABLE V.

Analyses, Molecular Proportions and Norms of Sitkose.

Composition.			Molecular Proportions		Norm		
	I.	II	I	II.		I.	II
SiO_2	67.04	65 94	1.117	1 099	Qu	28 68	30 1
Al_2O_3	11.40	13.74	.112	.134	Or	6.12	10 0
Fe_2O_3	.78	49	005	.003	Ab	23 06	23 6
FeO	3.75	5.21	.051	.071	An	15 85	14 2
MgO	3.52	2.33	.088	.058	C		2 0
CaO	7 60	2.87	.136	.051	Di	16 96	
Na_2O	2.70	2.80	.044	.045	Hy	3 96	13 6
K_2O	1.00	1.63	.011	.018	Mag.	1 66	.7
H_2O+	.16	2.59			Ilm	3.19	1.5
H_2O-	.09	.21			Ap	34	
CO_2	none	.59					
TiO_2	1.68	.80	.021	.010			
P_2O_5	.12	.21	.001	.002			
Total	99.84	99.41					

[1] Becker, *Annual Rept. U. S. G. S.*, XVIII, Pt. III, p. 43.

I. Analysis, molecular proportions and norm of sitkose from Fisherman's Island, Me.

II. Analysis, molecular proportions and norm of sitkose from Alaska, described by Becker; analysis, by Hillebrand. Analysis and norm published in Washington's tables, *Prof. Paper 14, U. S. G. S.* p 219. (.61% of rare oxides omitted.)

The Maine rock is perfectly fresh as regards weathering; the Alaska one contains notable amounts of water and of carbon dioxide and is described as containing secondary chlorite, calcite and muscovite. The comparison between them cannot therefore be pushed too far. It is well known that in the weathering process the lime is the first constituent to be attacked and that of all the others alumina is the most constant actually, but apparently grows greater because of the percentage decrease in the others. These two analyses would be much closer if a recasting were made because of weathering.

Norm and Mode.—In the less crushed varieties of the Maine rock the mode differs from the norm mainly in the entire absence of anorthite and the presence of various calciferous alferric minerals. Titanite is moderately abundant, thus using up the ilmenite molecule in combination with CaO. There is a very little biotite, which calls for a slight re-arrangement of the potash molecules.

Metamorphism.—As a rule the rock has been greatly sheared. The shearing took place in some instances along the strike of the dike, in some directly across it, and in some obliquely. The result of the shearing is seen in granulation of the quartz, undulatory extinction of quartz and feldspars, bending of the feldspar lamellæ, cracking of the feldspars and the presence of the metamorphic minerals microcline, actinolite and zoisite.

Grano-tonalose. II. 4. 3. 4. (Quartz-mica Diorite). *Occurrence.*—The rock which falls into this subrang makes up the greater part of the island of Southport, where it is found in irregular masses of bathylithic or laccolithic character. The same type of rock occurs to some extent in the form of dikes on the mainland.

Megascopic Character.—It is a fairly coarse-grained light gray rock of granitic texture occasionally gneissoid. In the field it

can readily be distinguished from all other granitic types of the region in that its color tones are all of black and white order. The other granites are pinkish, greenish or brownish in tone.

TABLE VI.

Analysis and Norm of Tonalose from Southport.

Composition.		Molecular Proportions.	Norm.	
SiO_2	63.44%	1.057	Qu	17.58
Al_2O_3	18.84	.184	Or	11.68
Fe_2O_3	.16	.001	Ab	36.15
FeO	4.05	.056	An	19.18
MgoO	1.99	.049	Cor	2.55
CaO	4.23	.075		
Na_2O	4.35	.069	Hyp	9.78
K_2O	2.07	.021	Mag	.23
H_2O+	.33		Ilm	2.74
H_2O-	.06		Ap	.67
CO_2	none			
TiO_2	1.41	.018		
P_2O_5	.32	.002		
Total	101.25			

Microscopic Character.—This rock type is too common to make extended comment desirable. It contains orthoclase, plagioclase, biotite and quartz, in order of abundance, with a little accessory magnetite and apatite and a moderate amount of titanite.

Metamorphism.—There is evidence of strain, though not of as intense degree as in the case of the Damariscove lassenose. A little undulatory extinction, a few individuals of microcline and considerable cracking of the feldspar are the evidences of it. There is a little kaolin developed along the cracks in the feldspar, and some chlorite borders the biotite.

The Germanares (II. 5). (Augengneiss; Monzonite; Gabbro; Anorthosite.) In the *Journal of Geology* for April and May, 1906, is a paper by Edson S. Bastin on prowersose from Knox County, Maine. The rock I am about to describe appears to be another occurrence of the same type. The points of similarity will be evident on comparison with Mr. Bastin's description. The Boothbay rock is variable in structure, mineralogy and chemical

composition. Of the various types selected by us for analysis and for microscopic study no one is identical with his, yet our types from the same rock mass differ from another in as essential respects as do most of them from his rock. The Boothbay rock is invariably porphyritic, the phenocysts being feldspathic, the ground-mass micaceous. On analysis, the ground-mass only [1] corresponds to Mr. Bastin's analysis and falls into the subrang prowersose. The whole rock of each of our types is more salic, and the various types respectively fall into the subrangs monzonose, umptekose and the unnamed subrang (II. 5. 3. 2.) of which the only analysis given in Washington's tables is that of the augite-minette from the Plauensche Grund of Dresden. Since the Maine rock is of notable extent, and the analysis accurate and from fresh material, it appears justifiable that a name from this locality be given to this subrang of the new system, and the name *lincolnose* is here proposed for it from Lincoln County, Maine.

The Boothbay rock (including umptekose, monzonose and lincolnose) is found in two parallel bands about two miles apart. The eastern band outcrops on Squirrel Island (see map, Fig. 2) and again on Spruce Point. In both localities it has been much cut up by later intrusives. Its strike varies from due N.-S. to N. 15° E. and it may be found at intervals throughout the length of the quadrangle. It forms Mt. Pisgah and there has a width of about a quarter of a mile. This band was traced in the direction of its strike for twelve miles, the width being very variable. It is often concealed by vegetation and sometimes appears to pinch out altogether. The indications point towards a string of lens-shaped masses barely connected with each other and arranged in a uniform direction. The western band is shorter and wider being apparently three miles in length and one in maximum width. Its widest part is found on the south shore of Campbell pond; from there it extends southward rapidly narrowing to the coast. Mr. Bastin's exposures are about forty miles distant in a N. 20° E. direction.

Wherever exposed on the Boothbay quadrangle both bands show a marked difference between core and edges. The core

[1] See Analysis II, Table VII.

consists of a very friable, easily weathered, dark rock, which usually forms a depression. It consists of blue "augen" an inch or less in length in a ground-mass of brown mica and feldspar. The augen are without orientation, and the mica plates also have no uniform arrangement. In the border zones the rock is schistose. The biotite and the augen are arranged with the long axes in the same direction. The latter often being completely crushed and represented by white bands between the mica plates. This border rock resists weathering much better than the rock of the core, hence it usually forms ridges. It is not among the hardest rocks of the region, but it is sufficiently resistant to form hills of moderate altitude. Fresh specimens of the border rock can readily be found, while the core disintegrates so readily that it might easily be overlooked altogether, and fresh specimens are difficult to obtain.

Microscopically the augen are found to be similar to the graphic granite which forms one of the youngest intrusions of the region. They consist of albite, microcline, microperthite and orthoclase, in order of abundance, with sometimes a little quartz. A few scales of mica are to be seen scattered through the augen, especially in the sheared varieties. Zonal structure is common in the feldspars. The augen are essentially similar in all varieties of the rock, differing only in degree of metamorphism. In some instances they are cracked, the cracks being filled with either quartz or muscovite, the former containing dark inclusions. Other occurrences are granulated on a microscopic scale, and still others are so completely crushed that they are drawn out into bands and are white megascopically.

The feldspars contain large numbers of inclusions. Quartz, titanite, perofskite, magnetite and rutile could be identified, the needles of the last-named being usually arranged in two intersecting directions. In the following analysis, care was taken to exclude as far as possible the scales of biotite which are occasionally within the augen. The mica of the ground-mass adheres most persistently to the augen, and particular care was taken to break it away. Considering these precautions, the amounts of iron, magnesia and titanium are very large; they are undoubtedly to be accounted for in the inclusions, as is some

of the quartz. The amount is so large that the analysis can be classified as a whole rock, falling into the subrang I. 5. 1. 3, phlegrose. Since the inclusions in these feldspars are of precisely the same type as those in other rock types of the region, the conclusion seems justified that the inclusions described elsewhere are of the same type.

The high alkalies and low lime are noteworthy and correspond with the absence of lime feldspar. This again is a general characteristic of the igneous rocks of the whole region, lime whether great or small in amount being invariably in a ferromagnesian mineral and nearly or quite lacking in the feldspar.

TABLE VII.

Analyses and Molecular Proportions of Monzonite from Spruce Point, Me.

	I		II	
SiO_2	65 69%	1.095	55 95%	.933
Al_2O_3	18.54	.181	12 28	.121
Fe_2O_3	.66	.004	25	.002
FeO	.50	.007	5 61	078
MgO	.12	.003	9.17	1.48
CaO	99	.017	4 63	.082
Na_2O	5 55	.090	1.91	.031
K_2O	7 30	.078	6.28	.067
H_2O+	.09		18	
H_2O-	.01		.05	
TiO_2	.55	007	3 15	.040
CO_2	none		none	
P_2O_5	.25	.002	83	.006
Total	100.26		100.29	

I. "Augen" from monzonite of Spruce Point, Me. Position in the quantitative system, I. 5.1.3. Phlegrose.

II. Schistose ground-mass of monzonite from Spruce Point. Me. Position in the quantitative system III.5.2.2. Prowersose.

Table VII. gives the analysis of the augen and also of the ground-mass. The distribution of ingredients is evident without especial comment. The potash is noteworthy, being high in both parts and is of course in orthoclase in I and in biotite in II. A more detailed description of the whole rock will be given under monzonose.

Lincolnose. II. 5. 3. 2. As already mentioned this new name is proposed for the soft rock which forms the core of both intrusions. Megascopically it is seen to contain large blue augen set in a ground-mass which is dense and dark except for mica scales.

Microscopic Character.—The augen are found to be in all respects similar to those already described, and are of the least crushed variety. In the ground-mass are found biotite, pyroxene, hornblende, titanite and magnetite, with a very little microcline, and more plagioclase, which is partly labradorite and partly albite, and a little microperthite.

There are three types of pyroxene. One of these is an ordinary colorless or greenish augite, remarkable only for its inclusions. The inclusions are opaque black grains or rods, probably of titaniferous magnetite, and are so abundant as to make the augite appear opaque. Prismatic faces are occasionally present in this augite, but terminal faces are lacking. About the edges there is frequently an intergrowth of biotite along the cleavage cracks, and biotite and brown hornblende together frequently form rosettes which seem derived from the augite by dynamic metamorphism.

The second type of pyroxene is faintly pleochroic from pink to violet and has an extinction angle (measured from C in the plane 010) which varies from 0° to 13°. In addition to the ordinary pyroxene cleavage, a parting parallel to 100 can be plainly seen, and a less distinct parting parallel to 010. These properties seem most nearly to correspond to diallage. This mineral contains great quantities of brownish red inclusions, apparently both rutile and titaniferous magnetite being present. Crystal boundaries are lacking in the diallage. It is usually surrounded by biotite and brown hornblende.

The third type of pyroxene is apparently secondary, the result of dynamic metamorphism of either of the two preceding types, and is usually associated with the rims of biotite and hornblende. It occurs in irregular grains, without inclusions, is frequently twinned, and is occasionally altered to uralite.

The hornblende is reddish brown and occurs in two ways.

As already implied, one of these occurrences is evidently secondary after the pyroxene, it and the biotite being together arranged in rosettes or rims around the augites. The other type of hornblende is also brown, but it forms large individuals and is apparently original. It is rare. Considerable apatite is present in long prisms containing transparent inclusions arranged parallel to the axis.

The biotite is evidently poor in iron, ranging in pleochroism from yellow to reddish brown. As an original mineral it is found in scales, which are frequently bleached at the edges. The secondary biotite consists of small individuals associated with the alteration of the pyroxene.

Chemical Composition.—Analysis I, Table VIII, is of the typical lincolnose from the core of the western intrusion.

Meta-monzonose. II. 5. 2. 3. *Occurrence.*—Bordering the lincolnose on both sides is the schistose portion already mentioned, of which the analyses in Table VII give separately the composition of augen and ground-mass. This differs from the lincolnose not only in having a schistose structure and in being less easily weathered, but also chemically and mineralogically. The augen are similar to those of the lincolnose but are more frequently crushed, especially near the edges of the rock mass. The ground-mass is quite different. It contains mainly biotite with little green hornblende and very little augite, which is surrounded by large rims of secondary brown hornblende. Biotite, microcline, microperthite, albite and a little quartz with titanite and magnetite make up the rest of the rock. There is great strain in the feldspar. The biotite is bleached along its edges. Analysis II in Table VIII is compounded of the two analyses in Table VII in the proportion of two parts of the augen to three of ground-mass, which is the ratio in which they were observed in the slides.

Meta-umptekose. II. 5. 1. 4. In the northern part of the Boothbay quadrangle the rock re-appears about two miles east of South Newcastle. In this locality is found the third type. Here the augen are without orientation and there is little or no schistosity, in which it resembles the type first described (lincolnose). The rock is of moderate hardness and not readily

weathered, in which it resembles the second type (monzonose). It differs from both in that the ground-mass is lighter colored, and the general tone of the rock is greenish gray rather than black.

Microscopic Character.—The lighter color is found to be due to the presence of a larger proportion of orthoclase, albite and quartz, with less mica, and the green tone to the presence of green hornblende.

Hornblende is the prevailing femic mineral and is of two varieties, a deep reddish, basaltic variety and a colorless or greenish one. The latter is frequently twinned. Biotite is present, frequently intergrown with the colorless hornblende, in which relationship the biotite appears to be the older. Titanite and apatite are abundant. The titanite is remarkable for having double refraction and slight pleochroism from colorless to reddish. It has deep irregular cracks and polysynthetic twinning. It encloses apatite, and is frequently surrounded by rims of magnetite with the colorless hornblende. Pyroxene is entirely lacking. The analysis of umptekose is given in Column III of Table VIII.

TABLE VIII.

Analyses and Molecular Proportions of Monzonites.

	I.		II.		III.	
SiO_2	55.17%	.919	59.64%	.994	58.74%	.979
Al_2O_3	18.01	.176	14.76	.145	14.61	.143
Fe_2O_3	.08	.001	.41	.003	.48	.003
FeO	5.41	.075	3.57	.050	3.70	.051
MgO	5.29	.132	5.53	.138	5.47	.137
CaO	5.64	.119	3.17	.057	3.34	.060
Na_2O	2.12	.034	3.27	.059	5.70	.092
K_2O	5.48	.059	6.69	.071	3.79	.040
H_2O+	.29		.14		.27	
H_2O-	.01		.03		.17	
TiO_2	2.33	.029	2.11	.026	1.87	.024
CO_2	none		none		none	
P_2O_5	.25		.60		1.00	
Total	100.86		99.92		99.14	

TABLE VIII—*Continued.*

Analyses and Molecular Proportions of Monzonites

Norms.

I		II.		III	
Or	32 80	Or	39 47	Or	22.24
Ab	17 81	Ab	27 77	Ab	48 40
An	22 24	An	5.84	An	3 06
C	31				
		Di	7 06	Di	5.83
Hy	15 55	Hy	13 47	Hy	15.80
Ol	2 34	Il	3 85	Il	3.54
Il	4.31	Mg	.46	Mg	.70
Ap	1 96	Ap	13	Ap	2 33

I. Monzonite from Campbell Pond, Maine. Position in the quantitative system II. 5 3.4. Lincolnose.

II. Schist. Analyses I and II of Table VII combined in the proportions of 2 3. Position in the quantitative system II. 5.2.3. Monzonose.

III. Monzonite from South Newcastle, Maine. Position in the quantitive system II 5 1 4. Umptekose.

This group of rocks presents similarities to the shonkinites, yogoites and monzonites of the Bearpaw and Little Belt Mountains, and with the prowersose of Two Buttes, Col. It also has affinities with the ciminites and vulsinites of Italy. It has no close allies near at hand, except the prowersose described by Bastin, which is probably part of the same rock-body.

The similarity with the distant rocks is chemical only. The other types are unmetamorphic and in some cases surface volcanics. The Maine rocks are evidently of deep-seated origin, and highly metamorphic, the resulting mineralogy and structure departing widely from those of the allied types. The mode departs widely from the norm for the same reason, namely that the minerals actually present are in large part the result of dynamic processes, and are in general those of higher specific gravity than the normative ones.

THE SALFEMANES.

Meta-auvergnose. III. 5. 4. 3. Hornblende Schist. *Occurrence.*—Hornblende schists are common on the coast of Maine and common also on the Boothbay quadrangle. They are involved

with acid igneous rocks and with mica schists in a very complex way. As a rule the trend of the rock is the same as the strike of the schistosity, but there are occasional exceptions. The way in which it is caught in with other rocks is shown on the small map of Cabbage Island. It was not put on the large map, because the patches of it are so numerous and so small. There are, however, several large and persistent streaks of the rock. One of these is on Southport near Cape Newagen, where a band of it is cut by a large diabase dike. Another very persistent streak extended from near the head of Linekin's Bay northward for about five miles. It was from this band that the chemical analysis was made.

Megascopic Character.—The rock is somewhat variable in color, ranging from black to dark gray. In the black types hornblende is the only mineral distinguishable; in the gray, feldspar and hornblende. The gray portions are very distinctly banded, the bands consisting of alternating streaks of light and dark minerals. The black and the gray portions both show fissility, caused by a parallel orientation of the hornblende.

Chemical Character.—It is evident that the chemical association is with the diabases, though the lime is higher than is usual; the potash lower; and the sum of the alkalies is low as compared with lime.

TABLE IX.

Analysis and Norm of Meta-auvergnose from Bayville, Maine

Composition.		Molecular Proportions	Norm.	
SiO_2	49.00%	.816	Qu	.48
Al_2O_3	15.46	.152	Or	2.22
Fe_2O_3	2.58	.016	Ab	23.06
FeO	7.98	.111	An	28.91
MgO	6.46	.161	Diop	22.34
CaO	11.83	.211	Hyp	11.71
Na_2O	2.75	.044	Mag	3.71
K_2O	.44	.004	Ilm	6.84
H_2O+	.09		Ap	.67
H_2O-	.07			
CO_2	none			
TiO_2	3.72	.045		
P_2O_5	.30	.002		
Total	100.68			

Norm and Mode.—The correspondence between norm and mode is not close. The lime is not in anorthite, but in ferromagnesian minerals, mainly hornblende. The alumina is not all in feldspar, but also in hornblende giving an alferric mode. Diopside, hypersthene and ilmenite are lacking. The titanium is in titanite. The normative amounts of quartz, orthoclase, albite and magnetite are present.

Microscopic Character.—Green hornblende is found to be the prevailing mineral. It is arranged in parallel leaves, giving the schistose structure. The schistosity is not perfect, but is interrupted by many crumpled areas and by occasional patches where the minerals are without orientation. The texture simulates the granitic. Titanite is abundant. Plagioclase (albite and oligoclase) is moderately abundant, with a little orthoclase and less quartz. There is found to be no great mineralogical difference between the gray and the black types. The gray have been more intensely crushed and the light bands are due to granulated quartz and feldspars. These are present in the black variety also but are less crushed and so do not appear white in the hand specimen. There is a slight kaolinization of the feldspar. The orthoclase has inclusions of the reddish black dust mentioned before. Small amounts of apatite and magnetite are present.

Comparison with Monhegan Rocks.—The close analogy of this rock with those from Monhegan Island described by Lord[1] which fall into the same subrang is so striking that his analyses are reproduced for comparison together with ours. Since some of our later dikes also fall into this subrang, the discussion will be taken up after they have been described. The comparative table of analyses will be found on page 554.

The most conspicuous difference between the Monhegan rocks and the schist of the mainland is that the former contains olivine in both norm and mode, while the hornblende schist does not. Moreover there is a slight excess of silica in the schist, while two of the Monhegan rocks lack silica to the extent of having nepheline in the norm.

[1] *Am. Geol*, XXVI, pp. 340 and 346.

THE PERFEMANES.

Dunose. V. I. I. I. (Dunite). *Occurrence.*—This rock was found in a single exposure, close to the cross roads where the road from Bayville to Pleasant Cove intersects that from East Boothbay to Boothbay Harbor. The exposure was not large: the rock disappeared on the one hand under a vegetable garden, on the other it was cut off by the highway. The occurrence was apparently a dike.

Petrological Character.—In the hand specimen the rock was dense, black with green talcose spots, and fine textured. It proved on microscopic examination to be somewhat altered, but its origin could so clearly be seen that it is placed in the new system of classification.

Microscopically it was found to be mainly olivine. This is evidently of a very magnesic variety, magnetite and chromite enough being visible to use up all the iron shown in the analysis. There is present a small amount of an alteration product which has the strong double refraction, high interference colors, and low index of refraction characteristic of a carbonate. From the analysis it is evident that it must be magnesite, no lime being present. A little muscovite and a little chlorite are present. The green spots which were in evidence megascopically are found to consist of fibrous anthophyllite with a few small areas of opaline quartz. A few rosettes of serpentine are also to be seen.

These alteration products occupy relatively small areas and invariably occur either along the cracks of the olivine or else they retain the form of the olivine. It is evident that the original rock was pure olivine of the variety forsterite, with small amounts of magnetite and chromite. Fully three fourths of the areas of the slides are now occupied by these original minerals, and since the alteration products retain the olivine form, the inference is safe that no lime can have been lost in the alteration process. There is a little mica which may possibly be original. No feldspar or pyroxene is or has been there.

TABLE X.

Analysis of Dunose from near Bayville, Maine

Composition.		Molecular Proportions.	Norm.	
SiO_2	37.41%	.623	Or	2 22
Al_2O_3	2.18	.022	Ab	4.19
Fe_2O_3	3 64	.023	Cor	1.02
FeO	3.46	.048	Hyp	1.54
MgO	41.08	1.027	Ol	72.32
CaO	none		Mg	.02
Na_2O	.54	.008	Cmr	.32
K_2O	.41	.004	Il	.30
H_2O+	8.84			
H_2O-	.09			
CO_2	2.03			
TiO_2	.12	.002		
P_2O_5	.08			
Cr_2O_5	.16	.001		
Total	100 04			

THE DIABASE DIKES

Diabase dikes are well known on the coast of Maine. To the list of localities already reported should be added at least six dikes from the Boothbay quadrangle. The fiord character of the coast makes it impossible to determine whether one dike or several are present when the trend is such that they cross the bays, but wherever the alignment coincided we assumed one dike whatever the variation in width. The topography however is very suggestive of faulting and it is recognized that the alignment may be accidental in some cases. For this reason a series of microscopic slides was made and studied, of every exposure. The distribution of the dikes is shown on the map. The dikes described by Dr. Bascom from[1] the eastern part of the quadrangle are inserted on the map (Fig. 2.).

It will be observed that there are four dikes having a direction of N. 85° E. These dikes are all large, varying in width from thirty to one hundred and fifty feet. The southernmost one outcrops on the coast of Southport Island near Cape Newagen;

[1] "Dikes from the Vicinity of John's Bay, Maine," *Am. Geol.*, XXIII, 1899, p. 275.

the second is Dr. Bascom's, which has two outcrops on Rutherford Island, and one on the east side of Linekin's Neck; the third is the longest of them and outcrops on Cabbage Island, on the east and west coasts of Spruce Point, in the woods about a quarter of a mile inland on Southport, twice respectively on the east and west sides of the promontory of West Southport and in Georgetown north of Five Islands; the northernmost dike crosses Linekin Bay, being exposed on both coasts and on Cabbage Island. These four dikes are closely related in their petrographical characters, being porphyritic olivine diabases, and in their chemical characters, falling into Class III of the new system.

Another large dike is found on the mainland running parallel to the Sheepscot River with a strike of N. 10° E. This differs chemically and mineralogically from the others, being an acid, very feldspathic diabase without olivine and non-porphyritic, and falling into Class II of the new system.

The remaining dikes are small, varying from a few inches to a few feet in width. They are entirely variable in composition, and variable also in direction.

These three series were never found together so the age relations are unknown, but it is believed that there are two, possibly three, types distinct in age, and that this classification holds for other parts of the Maine coast.

Placerose. II. 4. 3. 5. Diabase. *Occurrence.*—The rock which falls into this subrang is the big dike with N. 10° E. trend, already mentioned (see Plate XXXI, Fig. 2). It has a maximum width of about thirty feet, with a length of more than four miles, during the greater part of which it is a conspicuous topographic feature. In two localities it disappears for a short distance, and in one place seems to be represented by three small dikes. It grows narrower towards the south; at its northern end it disappears suddenly. Its location can be seen on the map, where it will be found running parallel to the trend of the shore and a short distance inland.

Megascopic Character.—In the hand specimen the rock is a dense black or gray black, fine-grained trap. A few needle-like black crystals can be distinguished. In view of the apparent

basicity, the analysis was a surprise, and so was the position of the rock in the quantitative system. It falls into the same rang as a rock from Southport which in the field was considered a granite. Microscopic examination leaves no doubt that the analysis is correct, the black color being deceptive.

Microscopic Characters.—Thin sections show the rock to have a normal diabasic texture; to be of coarse grain, and to lack phenocrysts. The edges are finer than the center. The principal constituent is plagioclase, appearing as a network of lath-shaped crystals. The extinction angles of these were measured and they were found to be of two kinds: one corresponding to albite of the composition $ab_6\ an_1$, the other oligoclase, $ab_3\ an_1$. A microperthitic intergrowth of albite and orthoclase is of occasional occurrence, and one interesting type of intergrowth was seen, where laths of albite alternated with strips of microperthite. A fine dust of kaolin is to be seen in some of the feldspars. A few broad orthoclases are present. Anhedra of magnetite are common, occupying the interstices between the feldspars. The principal ferro-magnesian constituent is common augite which is entirely xenomorphic, consisting of long strips or of irregular areas between the feldspar laths. The augite is entirely fresh and without inclusions.

TABLE XI.

Analysis and Norm of Placerose from Dike near Sheepscot River.

Composition.		Molecular Proportions.	Norm.	
SiO_2	56.72%	.945	Qu	10.56
Al_2O_3	15.06	.148	Or	3.89
Fe_2O_3	1.73	.010	Ab	39.82
FeO	6.33	.088	An	18.07
MgO	2.58	.064	Diop	9.98
CaO	6.61	.118	Hyp	5.88
Na_2O	4.73	.076	Mag	2.32
K_2O	.69	.007	Ilm	7.55
H_2O+	.51		Ap	.98
H_2O-	.15			
CO_2	none			
TiO_2	4.04	.049		
P_2O_5	.40	.003		
MnO	.35	.004		
Total	99.91			

Slides of the three smaller dikes into which the large one appears to ramify in the middle of its extent show a similar diabasic structure, but a much finer grain and a porphyritic tendency. They show a felty appearance with fine feldspar needles in a mass of magnetite, with very tiny augite anhedra, and porphyritic plagioclase. The phenocrysts are of essentially the same size as the average crystals of the center of the large dike; the fineness of the ground-mass is the essential difference between the two.

In Washington's tables there are ten rocks within this subrang, none of which comes from eastern America. Several are dikes from California, but the one which is the closest analogue in analysis and in norm is a porphyritic lava from the St. Augustine volcano, Alaska.[1]

TABLE XII.

Analysis of Dike from Eastern Shore of Linekin Bay.

Composition.		Molecular Proportions	Norm.	
SiO_2	53.01%	.883	Qu	4.20
Al_2O_3	15.54	.152	Or	3.34
Fe_2O_3	1.85	.011	Ab	20.44
FeO	6.09	.096	An	29.75
MgO	7.70	.192		
CaO	10.60	.189	Diop	18.40
Na_2O	2.37	.039	Hyp	18.92
K_2O	.62	.006	Ilm	3.04
H_2O+	.73		Mag	2.55
H_2O-	.47			
CO_2	none			
TiO_2	1.70	.020		
P_2O_5	trace			
S	trace			
Total	100.68			

Auvergnose. III. 5. 4. 3. Diabase. *Occurrence.*—This rock is found in the form of a dike on the eastern side of Linekin's Bay. The dike is about ten feet wide near the shore; it may be followed for some rods inland, until it disappears under vegetation. The most vigorous search did not bring it to light farther east. Westward it re-appears on Cabbage Island, where it has

[1] See Becker, *Annual Rept. U. S. G. S.*, XVIII, Pt. III, p. 52.

a width of thirty-five feet, and again on the western shore, where it is still wider. On this latter exposure are glacial striæ pointing N. 10° W. The slightly inclined columnar structure is evident here as elsewhere among the dikes.

The subrang is a very common one, the most notable thing about it being that within it are to be found four of the rock types described by Mr. Lord from Monhegan Island. Of these, two, malchite and beerbachite, are dikes; two, gabbro and gabbro diorite, are part of the older plutonic mass. The resemblance to the Linekin diabase is chemical only, the mineralogy being quite different.

Microscopic Character.—The Linekin dike has a diabasic texture, in which it is like the Sheepscot River dike just described, but the resemblance is only of a very general nature. The Linekin dike is porphyritic throughout, its principal phenocryst being a broad plagioclase of the variety labradorite; other phenocrysts are augite and olivine. The augite is usually surrounded by secondary hornblende. The ground-mass consists of a network of lath-shaped plagioclases, in the interstices of which are magnetite and augite. This dike is in all respects similar in petrographic character to the one described by Dr. Bascom, hence mineralogical details need not be repeated Identical with these is the long dike extending from Cabbage Island to Five Islands. All are porphyritic olivine diabases, with slight variations in coarseness of grain according to distance from the edges.

The southernmost of these east and west dikes, which outcrops on the coast near Cape Newagen, shows considerable metamorphism. The dike is the largest, measuring (by pacing) one hundred and twenty feet in width. The original rock was evidently identical with the others, but in places it has been so crushed as to be practically a hornblende schist. Of the six slides examined from different parts of this exposure all degrees were to be observed between a slightly altered diabase with a little green hornblende in addition to the minerals enumerated above, to a true schist with hornblende and biotite as the only ferro-magnesian minerals, and a schistose arrangement of these leaves. The commonest type is a partly altered one containing

green hornblende without orientation, with the diabasic texture in part interfered with by the green hornblende which cuts the feldspar boundaries.

As indicated on the map, there is another outcrop of this dike to the west. This is a small area in the woods, no other rock being visible and a few feet only of the diabase exposed. Thin sections show this to be identical with the shore exposure, but of coarser grain. It is evident that a large proportion of the width of the dike is covered by vegetation, since its grain is too coarse to be produced in the width exposed.

An estimation of the contents of these dikes leaves no reasonable room for doubt that they would all fall into the subrang auvergnose. The Cape Newagen dike forms a connecting link between these dikes and the older complex. It is practically intermediate between the diabases and the hornblende schist of this same subrang.

The smaller dikes, although diabases, present notable differences, from all of the above and from each other. On Capitol Island are two, of which one has a nearly east and west, the other a nearly north and south trend. The first mentioned has a strike of N. 80° E. and is exposed on and near the western shore. A gorge on the mainland of Southport indicates that the dike continues there, but no material could be found in the latter locality. Microscopically it is found to be a porphyritic diabase, with phenocrysts of plagioclase with less augite and olivine. In the ground-mass are plagioclase and augite. Its affinity is with the east and west large dikes (auvergnose), but there is a larger proportion of augite in the ground-mass and the diabasic texture is not perfect. The plagioclase phenocysts are older than the femic ones and sometimes are entirely surrounded by them. In such occurrences the edges of the plagioclase are corroded and the femic silicate enters it irregularly, notably along the twinning planes. Titanite and grains of magnetite are present in notable amount. Much of the olivine is altered to brownish green serpentine and a carbonate.

The north and south dike of Capitol Island is exposed in a bay on the southern shore, and after extending about one hundred feet inland the strike turns to N. 20° E. Microscopically it is

much finer grained than the other dike, and is a peculiar rock with no ferro-magnesian minerals in evidence. Phenocrysts and ground-mass are both of plagioclase while a dendritic form of magnetite makes up a large proportion of the rock penetrating both phenocrysts and ground-mass. The feldspar phenocrysts show a kind of twinning unusual in this mineral, the laths crossing each other in a manner resembling the twinning of staurolite. Other phenocrysts are H-shaped, the two vertical arms having a similar orientation, the cross-piece being placed at right angles to the others. A few faint outlines suggest augite, but magnetite now makes up their bulk with a dust of a brownish substance which under a high power seems to be a laminated serpentine. It has a cleavage and is probably antigorite. It does not seem to occupy space formerly held by another mineral, but to be redeposited.

On the western shore of Ocean Point is another small dike. The dike itself is only about ten inches wide, but a chasm four or five feet wide has been eroded along it (see Plate XXXII, Fig. 2). The gully on this dike is about two hundred feet long and has a strike of about N. 65° E. The dike rock is a diabase, slightly vesicular on one surface. Microscopically the rock is found to be porphyritic, but the phenocrysts are completely altered. There seem to be three types of alteration product, one of which is kaolin and muscovite and is probably derived from feldspar; another is a green serpentine, probably from augite; and the third a gray serpentine with calcite and quartz, probably from olivine. In the ground-mass is much pyrite and a network of plagioclase with needles of a hornblende which is pleochroic in brown and pink, and a little actinolite. The texture is not typically diabasic, some feldspar occupying the interstices.

Some rods farther north is another dike identical with the last. It is only three inches wide but forms a chasm.

STRIKING PETROGRAPHICAL FEATURES ILLUSTRATED ABOVE.

The magmatic relationship of the trap dikes to the older metamorphic complex is admirably illustrated on the Boothbay quadrangle. The similarities will be apparent after an inspection

of the following table to which are added all rocks from the same subrang that have previously been analyzed from the immediate vicinity.

TABLE XIII.

Analyses of Auvergnose from the Coast of Maine.

	I.	II.	III.	IV.	V.	VI.
SiO_2	49.00%	53.01%	46.29%	45.66%	44.79%	47.20%
Al_2O_3	15.46	15.54	17.16	16.26	15.18	18.64
Fe_2O_3	2.58	1.85	2.57	2.97	4.13	1.96
FeO	7.98	6.09	9.87	8.51	8.21	6.82
MgO	6.46	7.70	7.79	10.21	7.93	8.28
CaO	11.83	10.60	12.04	12.25	14.10	11.52
Na_2O	2.75	2.37	2.21	1.34	2.18	2.91
K_2O	.44	.62	.16	.31	.30	.28
H_2O+	.09	.73				
H_2O-	.07	.47				
CO_2	none	none				
Ign			.51	.92	1.33	1.44
TiO_2	3.72	1.70	1.21	1.39	1.84	.84
P_2O_5	.30	trace	n.d.	n.d.	n.d.	n.d.
Total	100.68	100.68	99.81	99.82	99.99	99.89

Norms of Auvergnose.

	I.	II.	III.	IV.	V.	VI.
Qu						
Or	.66	4.20				
Ab	2.22	3.34	1.1	1.7	1.7	1.7
An	23.06	20.44	18.3	11.0	12.6	21.5
Ne	28.63	29.75	36.4	37.5	30.6	36.7
Di					3.1	1.7
Hy	22.77	18.40	19.5	19.3	31.8	16.6
Ol	11.50	18.92	2.4	11.2		
Mt			15.8	11.2	9.5	15.9
Il	3.71	2.55	3.7	4.4	5.8	3.0
Ap	6.99	3.04	2.2	2.6	3.6	1.5
	.67					

I. Hornblende schist from Bayville. (See p. 543).
II. Diabase dike from east side Linekin's Bay. (See p. 550).
III. Beerbachite. Lord, *A. G.*, XXVI, p. 346. Monhegan Island. (Dike.)
IV. Malchite. Lord, *A. G.*, XXVI, p. 346. Monhegan, Island. (Dike.)
V. Hornblende-gabbro. Lord, *A. G.*, XXVI, p. 340. Monhegan Island.
VI. Gabbro-diorite. Lord, *A. G.*, XXVI, p. 340. Monhegan Island.

The general similarity among all six of these types is evident.

All of the chemical ratios are essentially the same, as is of course indicated by the fact that they fall into the same subrang. The similarity is such as to indicate chemical relationship or magmatic unity between the plutonic metamorphic rocks of the older series and the younger diabases. This chemical and "normative" likeness is the more striking in that it is not accompanied by a mineralogical or model similarity. Any recalculation of the analyses of the older rocks in terms of the minerals that are actually there brings about an appearance of greater basicity than the normative relationship warrants. In the hornblende schist the amount of hornblende is so great as to give the rock every appearance of belonging among the basic gabbros. When interpreted in terms of standard minerals it becomes evident that the amount of hornblende has increased at the expense of anorthite molecules and that the rock is practically identical with the diabase.

In Table XIV the analysis of all the Boothbay types analyzed by us are repeated for comparison. It is evident that there is a regular progression in chemical characters from I to IX, and then a great difference when X is reached. It remains for future investigation to show whether types intermediate between IX and X are in existence, or whether X is really not a part of this co-magmatic region. The distribution of peridotite and allied dikes along the eastern parts of the United States is suggestive of other than purely local relationships for this rock. Leaving this dike aside we may thus sum up the chemical characters of the region: the range of silica is moderate and its amount intermediate, 49.00 to 67.59% being its extent. Alumina is moderate in amount and does not show any definite serial relation with other oxides. The ratios between lime, potash and soda are variable, but in general as the basic end of the series is approached, soda becomes in excess of potash, and lime in excess of the sum of the alkalies. Iron and magnesia, as well as lime, increase as the silica decreases; titanium is high throughout. In the majority iron exceeds magnesia, but magnesia increases relatively to iron as silica decreases.

TABLE XIV.

Analyses of Boothbay Rocks.

	I.	II.	III.	IV.	V.	VI.	VII.	VIII.	IX.	X.
	%	%	%	%	%	%	%	%	%	%
SiO_2	67.59	67.04	63.44	56.72	58 74	59.64	55.17	49.00	53.01	37.41
Al_2O_3	17.41	11.40	18.84	15.06	14.61	14.76	18.01	15.46	15.54	2.18
F_2O_3	.15	.78	.16	1.73	.48	.41	.08	2.58	1.85	3.64
FeO	2.98	3.75	4.05	6.33	3.70	3.57	5.41	7.98	6.09	3.46
MgO	1.40	3.52	1.99	2.58	5.47	5.53	5.29	6.46	7.70	41.08
CaO	3.05	7.60	4.23	6.61	3.34	3.17	5.64	11.83	10.60	none
Na_2O	4.89	2.70	4.35	4.73	5.70	3.27	2.12	2.75	2.37	.54
K_2O	2.59	1.00	2.07	.69	3.79	6.69	5.48	.44	.62	.41
CO_2	none	none	none	none	none	none	none	none	none	2.03
H_2O+	.18	.16	.33	.51	.27	.14	.29	.09	.73	8.84
H_2O-	.04	.09	.06	.15	.17	.03	.01	.07	.47	.09
TiO_2	.83	1.68	1.41	4 04	1.87	2 11	2.33	3.72	1.70	.12
P_2O_5	.19	.12	.32	.40	1.00	.60	.25	.30	trace	.08
MnO	n. d.	n. d.	n. d.	.35	n. d	n. d.	n. d.	n. d.	n. d.	.16Cr_2O_5
Total	101.30	99.84	101.25	99 91	99.14	99.92	100.86	100.68	100.68	100.04

I. Grano-lassenose, I. 4. 2. 4.
II. Meta-grano-sitkose, II. 3. 3. 4.
III. Grano-tonalose, II. 4. 3. 4.
IV. Placerose, II. 4. 3. 5.
V. Umptekose, II. 5. 1. 4.
VI. Meta-monzonose, II. 5. 2. 3.
VII. Lincolnose, II. 5. 3. 2.
VIII. Meta-auvergnose, III. 5. 4 3.
IX. Auvergnose, III. 5. 4. 3.
X. Dunose, V. 1. 1. 1.

METAMORPHISM.

Since unaltered dikes and metamorphic masses are clearly derived from the same magma, it becomes possible to estimate the kind and amount of alteration that has taken place in the metamorphic types. A comparison of the mode with the norm among all of the preceding metamorphic types brings out the fact that the difference between mode and norm is of a constant character, and that it is closely similar to the difference between the auvergnose dike and the meta-auvergnose. The presence of titanite seems to be an invariable character of the unaltered mode.

The following are the essential chemical differences between mode and norm in the metamorphic rocks:

1. The presence of alferric minerals, thus affecting the distribution of alumina.

2. The alferric mineral may be biotite, in which case there will be less than normative orthoclase.

3. The alferric mineral may be hornblende or augite of a lime-bearing variety, in which case there will be less than normative anorthite.

4. The quartz content will depend upon whether 2 or 3 takes place, or if both upon the amount of biotite formed. The silica in hornblende and augite is in approximately the same ratios as in anorthite; biotite does not require as much silica as orthoclase, hence more than normative free quartz will be present in the biotite rocks.

5. Zoisite may be present, affecting the distribution of lime and alumina.

6. Actinolite may be present, calling for a re-distribution of lime and iron and magnesia from diopside.

7. Normative hypersthene disappears under these rearrangements.

Soda invariably remains unchanged, in albite. Quartz rarely departs far from the estimated excess of silica.

In addition to these chemical characteristics, there are certain mechanical alterations, such as undulatory extinction, microcline twinning, and granulation.

A consideration of the minerals present and of the chemical possibilities brings out the fact that the mineralogy is characteristic of a zone of considerable depth. The minerals are those of high specific gravity and are almost without exception those that might be formed in igneous rocks under deep-seated conditions. The garnet-staurolite-tourmaline group of minerals, of still higher specific gravity and indicative of more intense or longer continued metamorphism[1] are entirely absent.

Reference should be made to the recent book of Grubenmann, *Die Kristallinen Schiefer*. This book aims to classify the metamorphic rocks on a basis primarily of chemical composition, and secondarily of the place where the metamorphism

[1] See Van Hise, *Monograph XLVII*, *U. S. Geol. Survey*, p. 183, *et seq.*

occurred. The chemical system used is the artificial one of Osann. From the metamorphic standpoint three divisions are made according to the depth at which the alteration took place, certain minerals being taken as indications of each zone. In its main lines Grubenmann's system is built upon precisely the foundation which is needed for a natural classification of the metamorphic rocks, but in its details it seems to be open to two objections. One of these is the artificial character of the chemical basis; the other, the practical difficulty of recognizing the rock types formed in the respective zones, since the several types of mineral sometimes occur in the same rock. This is especially the case with the middle and lower zones and it appears to be practically an impossibility to know from the minerals only to which of them a given rock type can be referred. The Maine rocks do not fit into either of the zones as defined by Grubenmann, though their resemblances are more nearly with the lowermost. The prefix "kata" is attached to this by him, which seems unfortunate as that has already been used by Van Hise in the word "katamorphism" as a designation of the highest zone.

It yet remains for future workers to determine whether it is possible to build up a system that shall accurately measure pressure, heat and stress by means of the minerals formed. In the present state of knowledge it appears better to attempt no such subdivision, but to designate by the prefix "meta" any kind of metamorphism exclusive of weathering, and to apply this prefix to the subrang name of the quantitative system.

The conception of metamorphism here entertained is that of alteration without addition or subtraction of material. Obviously rocks injected, cemented, weathered or otherwise chemically changed would not be available for classification in this manner. In the region here discussed there is no reason for suspecting any changes in chemical composition, and it is believed that the quantitative system furnishes the most logical method of regarding them.

PLATE XXXI.

PLATE XXXI.

PAGE.

FIG. 1.—"Graben" on Negro Island, Me. 523

FIG. 2.—Ridge formed through weathering of diabase dike away from the coast. Near Sheepscot River, Me. . . . 523

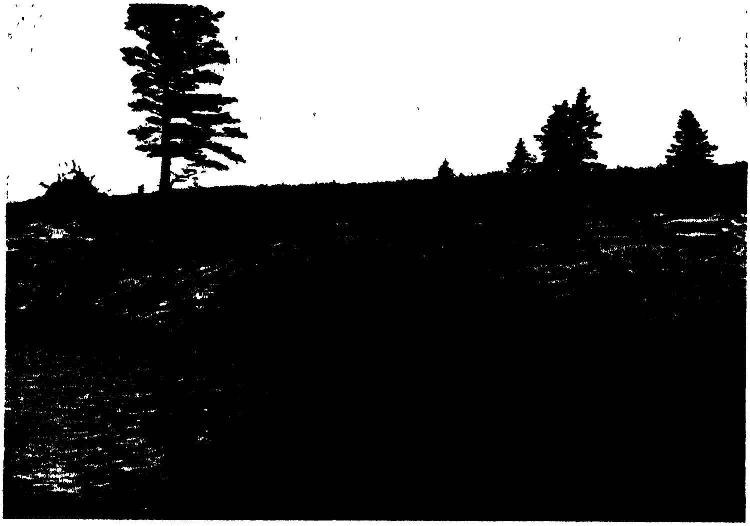

FIG. 1.

FIG 2.

PLATE XXXII.

PLATE XXXII.

PAGE

FIG. 1.—North Dike of Cabbage Island, Me., showing inclined columnar structure 523

FIG. 2.—Chasm formed by weathering of diabase dike on the coast. Ocean Point, Me. 523

FIG 1.

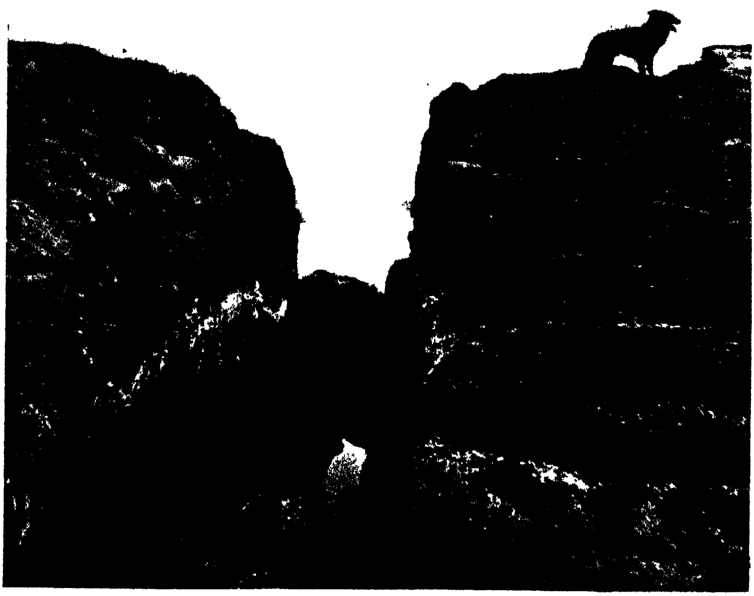

FIG. 2.

ANNALS

NEW YORK ACADEMY OF SCIENCES

Vol. XVII, Part III, December, 1907.

[ANNALS N. Y. ACAD. SCI., Vol. XVII, No. 6, Part III, pp. 563–657 (December, 1907)]

RECORD OF MEETINGS

OF THE

NEW YORK ACADEMY OF SCIENCES.

January, 1905, to December, 1905.

HERMON C. BUMPUS, *Recording Secretary.*

BUSINESS MEETING.

JANUARY 9, 1905.

The Academy met at 8.15 P.M. at the American Museum of Natural History, President Kemp presiding.

The minutes of the last meeting were read and approved.

The following candidates for election as Active Members, recommended by the Council, were duly elected:

J. H. Wilson	3120 Broadway
George H. Sherwood	American Museum Nat. History
Prof. Chas. Baskerville	College of the City of New York
Robert T. Hill	25 Broad Street
Maurice Fishberg, M.D.	79 West 115th Street
W. T. Roberts	108 West 84th Street
Roy W. Miner	435 West 123d Street

It was voted that Chapter V, Section 1 of the By-Laws be amended by omitting the following words:

"Every active member shall pay an initiation fee of five dollars within three months of his election or such election shall be void."

It was voted that the following recommendation of the Council be adopted:

"Active workers in science may at the discretion of the Council be elected to Associate Membership in the Academy in the manner prescribed by the By-Laws, with annual dues of $3.00 for a term of two years, and they may be re-elected.

Associate Members shall receive the publications of the Academy and may offer their papers for publication in the Annals and Memoirs, but because of constitutional provisions they shall not have the power to vote and shall not be eligible to election as Fellows. At any time subsequent to their election Associate Members may assume the full privileges of Active Members by the payment of the dues required by Chapter V, Section 1 of the By-Laws. Persons now Active Members may not be elected Associate Members."

The following resolution, having been presented by vote of the Council, was then adopted:

Resolved, That the Council of the New York Academy of Sciences place on record its warm interest in the efforts which are being made by the Peary Arctic Club under Mr. Morris K. Jesup as president to outfit another expedition to the polar regions under the direction of Commander Peary.

In the opinion of the Council, such an expedition may become one of great importance, and, in addition to the chief geographical objects of the expedition, valuable observations and discoveries may be made in the sciences of geology, terrestrial physics, geography, zoölogy, anthropology and botany.

Resolved further, That the Academy coöperate so far as possible with the Peary Arctic Club in raising funds not only in support of the chief object of the expedition, but, if the necessary additional funds can be secured, in support of a small scientific staff to accompany Commander Peary and make permanent observations and collections in the chief bases of the expedition *en route*.

The Academy then adjourned.

HERMON C. BUMPUS,
Recording Secretary.

SECTION OF GEOLOGY AND MINERALOGY.

JANUARY 9, 1905.

Section met at 8.40 P.M., Vice-President E. O. Hovey presiding.

Twenty-eight persons were present.

The minutes of the last meeting of the Section were read and approved.

The following program was then offered:

George F. Kunz,	THE JAGERSFONTEIN DIAMOND, THE LARGEST EVER FOUND: THE HISTORY OF ITS CUTTING AND ULTIMATE DISPOSITION.
John J. Stevenson,	THE COALS OF SPITZBERGEN.
James F. Kemp,	NEW SOURCES OF SUPPLY OF IRON ORE.

SUMMARY OF PAPERS.

Dr. **Kunz** said that the Excelsior-Tiffany diamond, the largest diamond ever found up to the present time, weighed 970 carats, and was a gem of most marvellous purity. This diamond was most expertly cleaved into pieces, and from it were cut ten gems weighing from 13 to 68 carats each, a total of 340 carats, and these were imported into the United States. Dr. Kunz also stated that carbon silicide had been detected in the meteorite from the Cañon Diablo by Dr. Henri Moissan of Paris, together with transparent diamond and black diamond. As carbon silicide has been made artificially with the electric furnace by Messrs. Cowles, Acheson, and Moissan heretofore, and was first determined in nature by Professor Moissan, if agreeable to Professor Moissan he would suggest the name *Moissanite* for this compound.

The paper was illustrated by models and photographs. It was discussed by Professors Kemp, Stevenson, the chairman, and others. Brief replies were made by Dr. Kunz.

Professor **Stevenson** said that the coals of Spitzbergen, according to Nathorst, are in great part of Jurassic age. The mining operations are confined to Advent Bay, a branch of the Icefiord of West Spitzbergen, where coal has been opened on both sides of the bay. The deposit has been followed northwardly for about ten miles, and for an equal distance westwardly.

The chief enterprise is on the easterly side of the bay, where the bed is somewhat less than five feet thick. The coal from the upper part is splint-like, while that from the lower part is brilliant and somewhat prismatic. The divisions show a notable difference in the percentage of volatile, the upper containing about ten per cent. more than the lower. The coal shows no tendency to coke, and that from the lower portion is attacked energetically by caustic potash.

The coal was compared with that from other localities in which the benches show notable difference in volatile. The results of tests with caustic potash made upon a number of coals appeared to show that non-coking coals are attacked promptly, while coals yielding a firm coke are not affected even after prolonged boiling. The speaker promised to give at a future meeting the results of an extended series of tests.

The paper was discussed by Professor Kemp and others.

The last speaker was Professor Kemp, who discussed new sources of the supply of iron ores. Emphasis was first placed upon the enormous demands made by the iron industry of to-day upon the mines of the United States, Great Britain, and Germany. The conviction was held by many that within fifty years the local American sources of rich ores, of whose existence we now know, would be exhausted and the iron masters would be compelled to seek new deposits. The following possible new districts were passed in review: the Labrador prospects discovered by Mr. A. P. Low of the Canadian Geological Survey, which might also ship to Europe; Adirondack areas of reported magnetic attraction and possible lean ores; the Temagami district and the Michipicoten range, Ontario; the southern continuation of the Marquette range beneath the drift; the southern half of the Mesabi probable syncline beneath the swamps northwest of Duluth, as suggested by C. P. Berkey; the Baraboo range; the deposits in Iron County, Utah, and in the Wasatch Mountains; the magnetites of southern California and the prospects in Washington and along the coast. The speaker emphasized the important reserves in the titaniferous magnetites and their great quantity.

Passing to Europe the new developments in Sweden at Gellivara and Kirunavaara were reviewed and the possibilities at Routivaara; also the Dunderland valley in Norway and the similar deposits farther north. Their relations to the smelting centres in Great Britain and Germany were explained and their comparative amount with the "minette" ores of France, Luxemburg, and Germany brought out. Other deposits in Spain, Algiers, Venezuela, India, Australia, and Shan-si in China were mentioned.

The necessary connection between the coal fields and any great development of the iron and steel industry was emphasized and the future of the three great producers of to-day forecast as involved in the permanency of the coals. The reserves of coal are greater in Germany and America than in Great Britain. The province of Shan-si, China, having rich stores of both coal and iron, seems to be the one possible new location of the future great iron industry.

Professor Kemp's paper was discussed by Messrs. McMillin and Kunz, the chair, and others. Replies were made by Professor Kemp.

A. W. GRABAU,
Secretary.

SECTION OF BIOLOGY.

JANUARY 16, 1905.

Section met at 8.15 P.M., Vice-President W. M. Wheeler presiding.

The minutes of the last meeting of the Section were read and approved.

The following program was then offered:

Esther F. Byrnes, TRANSITIONAL STAGES AND VARIATIONS IN CERTAIN SPECIES OF CYCLOPS.

W. M. Wheeler, ANTS THAT RAISE MUSHROOMS.

SUMMARY OF PAPERS.

Dr. **Byrnes** described the transitional stages and variations in some species of *Cyclops.* The species *C. signatus* occurs sexually mature in morphologically incomplete stages. It is then characterized by eleven antennal segments instead of the adult number, seventeen, and is comparatively small in size and pale in color. Large numbers of adults of the type *C. viridis* show striking variations in the armature of the swimming feet. Similar antennæ and fifth feet are correlated in one type of individual with the swimming feet of *C. parcus*, in another form with *C. viridis* (var. *americanus*), and in another with *C. brevispinosus.* Occasionally serial and lateral varia-

tions combine the swimming feet of *C. parcus* and *C. brevispinosus* in the same individual. These facts, together with the frequent replacement of setæ by spines, the constant association of the forms, and their occasional sequence in small aquaria, indicate a very close relationship among the species observed and suggest that they are transitional forms in the development of a single species.

Dr. **Wheeler** described the structure and ecology of many "ants that raise mushrooms," giving special attention to the species of Texas and Mexico, where his own studies of these ants were made. Numerous lantern slides illustrated this lecture, and at its close many slides from photographs of ants kept in captivity by Miss Adele M. Fielde were exhibited

M. A. BIGELOW,
Secretary.

SECTION OF ASTRONOMY, PHYSICS, AND CHEMISTRY.

JANUARY 23, 1905.

Section met at 8.15 P.M. at Fayerweather Hall, Columbia University, Vice-President E. R. von Nardroff presiding.

The minutes of the last meeting of the Section were read and approved.

The following program was then offered:

A. P. Wills, THE MAGNETIC SUSCEPTIBILITY OF WATER.

H. C. Parker, EXPERIMENTS RELATING TO THE CONDUCTIVITY OF POWDERS AT HIGH TEMPERATURES.

SUMMARY OF PAPERS.

In connection with Dr. **Wills's** paper, experiments were made with the large electro magnet of Columbia University to determine the magnetic susceptibility of water. With the aid of this magnet, which is one of the largest in existence, Dr. Wills found the coefficient of susceptibility of water to be -0.72×10^{-6}, and also to be independent of the field strength over a range from 4,000 to 16,000 C.G.S. units.

Dr. **Parker** said that when a conducting powder like graphite is mixed with a non-conducting refractory powder, the resistance

increases quite rapidly at first, as the proportion of graphite is decreased, then more slowly, and after a time reaches a critical point where there is no conduction or the graphite is destroyed by arcing.

When the percentage of the conducting powder is low, a mechanical separation or "striation" takes place on packing in the refractory tubes. Besides this an electrolytic separation usually takes place after a time and the conductivity of the mixture is destroyed by arcing.

A very great variety of substances and mixtures were experimented with in the search for a permanent compound of high resistance.

C. C. TROWBRIDGE,
Secretary.

SECTION OF ANTHROPOLOGY AND PSYCHOLOGY.

JANUARY 30, 1905.

The Section met at 4.15 P.M. at Columbia University, and at 8.15 P.M. at the American Museum of Natural History, Vice-President F. E. Woodbridge presiding.

The minutes of the last meeting of the Section were read and approved.

The following program was then offered:

At the afternoon session:

R. S. Woodworth and
F. G. Bruner, COLOR PREFERENCES.
M. Tsukahara, THE RELATION OF INTENSITY OF SENSATION TO ATTENTION.
Dickinson S. Miller, IDEAS AND TEMPERAMENTS.

At the evening session:

Robert MacDougall, ORGANIC LEVELS IN THE EVOLUTION OF THE NERVOUS SYSTEM.
Robert MacDougall, NOTE ON NUMBER HABIT.
W. P. Montague, RELATIONAL THEORIES OF CONSCIOUSNESS.
Charles H. Judd, RADICAL EMPIRICISM AND WUNDT'S PHILOSOPHY.

The Section met in conjunction with the New York Section of the American Psychological Association.

SUMMARY OF PAPERS.

Drs. **Woodworth** and **Bruner** said that tests of different races, made at the St. Louis Exposition, showed that red was the color most often preferred, both by men and by women, and by all the races tested. The predominance of red choices was very great. Now previous authors have found, in the white race, that red was a woman's choice, but blue that of most men. This difference of result, as between the present and previous authors, is probably due to the different material used for presenting the colors—colored papers having previously been employed, whereas in the present tests use was made of colored worsteds, such as are used in the Holmgren test for color blindness. Special tests showed that the same individual is very likely to express a different preference, according as the colors are presented in paper, worsted, or glass. Many persons were also found to dislike strongly the colors of the rose, the violet, and the sunset, when presented in paper or worsted. The inference is that the "color-tone" is by no means a compelling factor in determining likes and dislikes of colored objects.

Dr. **Tsukahara** said that in an experimental study of the effects of distraction on the apparent intensity of a stimulus, a new method of distraction was employed. Two sorts of stimulus—the sound of a falling ball and the impact on the skin of a falling hammer—were employed, and sometimes presented simultaneously, so that the attention had to be divided between them. For instance, first a sound was given; next, simultaneously, a sound and an impact; and last an impact alone. The subject was required to compare the intensities of the two sounds and also of the two impacts. The result was that, contrary to the conclusion of Münsterberg, distraction *decreased* the apparent intensity of the stimuli; but this result is so far merely provisional.

Dr. **Miller** stated that in the psychology of intellectual bias one may study the individual or type in its relation to a variety

of ideas, or the idea in relation to a variety of individuals or types. Attempting the latter with the so-called "ideas of the French Revolution," liberty, fraternity, equality, reason, the natural goodness of man, and the rights of impulse, spontaneously advocated in literature, we find that different phases of these ideas must first be distinguished. As regards the ideas in these phases, the sympathy or antipathy of authors is found to depend in a determinate manner on the temperamental type.

Dr. **MacDougall,** in his paper discussing the organic levels in the evolution of the nervous system, said that the relation of organization to discriminative reaction may be stated in terms of four types, the non-nervous, the ringed nervous, the segmented, and the cephalic. The types were described.

In his second paper, Dr. MacDougall said that by number habit is meant the distribution of frequency in the recurrence of each of the digits when the choice is determined by mental constitution rather than objective evidence. Previous reports have given two types, a curve (Minot's) in which the changes from figure to figure are slight, presenting a high plateau in the middle of the series with a depression toward either end; and a curve (Dresslar's and Sanford's) in which maxima systematically appear in the odd numbers and minima in the even. From an apparently similar series of guesses in the present case a curve was obtained presenting three different levels. Zero and five formed maxima in relation to which all the other digits fell in a low plateau, and of the rest the even numbers formed maxima and the odd minima throughout.

Dr. **Montague** stated that the new movement in favor of a relational theory of consciousness is to be welcomed in the interest of a scientific psychology. It is, however, seriously hampered by a failure on the part of most of its advocates to realize the incompatibility of any form of idealism with the view that consciousness is a relation between its objects, and not something in which they adhere. Things must be before they can be related; hence if consciousness is a relation no object can depend for existence upon the fact that it is perceived. In short the realistic theory of the world is a necessary implication of the relational theory of consciousness; while,

conversely, if we follow common-sense in admitting the effective reality of both primary and secondary qualities, there will be no temptation to treat consciousness as anything other than special relation between an organism and its environment. Realism and the relational view of consciousness are strictly correlative. They are different aspects of the same truth, and cannot be defended or understood apart from one another.

Dr. **Judd** stated that Wundt's critical realism is closely related in its fundamental positions to James's recent philosophical discussions. Reality and immediate experience are made synonymous by Wundt. The concept of consciousness is not like the concept matter of the physical sciences, but includes only the immediate processes of experience in their totality. On the basis of these closely related fundamentals Wundt develops the details of his system in such a way as to emphasize the distinctions between physical and psychical phenomena, while James strives to minimize these distinctions.

R. S. WOODWORTH,
Secretary.

BUSINESS MEETING.

FEBRUARY 6, 1905.

The Academy met at 8.15 P.M., President Kemp presiding.

The minutes of the last meeting were read and approved.

No business was reported from the Council and the Academy adjourned.

HERMON C. BUMPUS,
Recording Secretary.

SECTION OF GEOLOGY AND MINERALOGY.

FEBRUARY 6, 1905.

Section met at 9.20 P.M., President Kemp presiding.

The minutes of the last meeting of the Section were read and approved.

The following program was then offered:

George F. Kunz, (a) MOISSANITE, A CARBON SILICIDE FROM THE CAÑON DIABLO METEORITE (by title).

George F. Kunz, (b) ON ZIRKON FROM NEAR LAWTON, OKLAHOMA (by title).
(c) ON MONAZITE SAND FROM IDAHO (by title).

V. F. Marsters, THE SERPENTINES AND ASSOCIATED ASBESTOS OF BELVIDERE MOUNTAIN, VERMONT.

Charles P. Berkey, INTERPRETATION OF CERTAIN INTERGLACIAL CLAYS AND THEIR BEARINGS UPON MEASUREMENT OF GEOLOGIC TIME.

A. W. Grabau, EVOLUTION OF SOME DEVONIC SPIRIFERS.

SUMMARY OF PAPERS.

Dr. **Marsters** stated that Belvidere Mountain lies approximately along the line between the counties of Orleans, Lamoille, and Franklin. It is a sharp-crested ridge with a maximum elevation of some 2100 feet above Eden Corners at its southern termination. Three topographic elements are prominent—a sharp-crested ridge forming the upper 900 feet of the mountain, a cresentric plateau with a flat top 1200 feet above the valley floor and rimming the end of the mountain, and lastly a steep lower slope composing the foot of the plateau and extending to the valley bottom.

The upper part with steep slopes is composed of amphibolite. In addition to the hornblende, which makes up seventy-five per cent. of the rock, there is also present an inconsiderable amount of epidote and a non-pleochroic colorless mineral regarded as zoisite, together with magnetite and pyrite. Towards the base, garnet becomes a prominent constituent, sufficient to make a well-defined garnet zone. In nearly all cases observed the garnet is largely altered to penninite, a variety of chlorite. Along the garnet zone the hornblende has also undergone marked alteration, in part to serpentine. The nose-like projection forming the plateau is composed of serpentine. In this rock occur the so-called asbestos, deposits recently prospected and worked for this product. In thin section the serpentine appears to be made up largely of a felty and fibrous mass, apparent only under cross nicols. It is typical fibrous

serpentine. In thin sections from the upper part of the plateau, and in close proximity to the overlying amphibolite, there appear shredded masses presenting the original structure of hornblende as seen in the amphibolite, but mineralogically altered to a fibrous mass with the optical characteristics of anthophyllite. It is not improbable, moreover, that a portion of the hornblende has altered to tremolite. These fibrous constituents form the so-called "slip-fibre."

The serpentine belt has also been subjected to peculiar faulting and crushing. The cracks thus produced, even on a microscopic scale, have been filled with these fibrous constituents and then the whole mass submitted to further slipping. This has caused the slickensiding phenomena on the fracture planes and a consequent stretching of the fibrous content; hence the term "slip-fibre". "Cross-fibre" or true thrysotile is to be found in this area. It is best developed along lines of maximum fracture and minimum lateral thrust. There appear to be two bands of maximum fracture, one stretching along the upper portion of the plateau and not far from the garnet zone, the second along the foot of the plateau and best shown on the property of Judge Tucker.

Dr. **Berkey** said that laminated clays of Glacial and Post-glacial age are abundant in many districts of the Northern States and Canada. They are especially abundant about the head of Lake Superior, where the origin of the deposits is intimately related to the closing fluctuations and final withdrawal of the Wisconsin ice-sheet.

One of these deposits at Grantsburg, Wis., exhibits a remarkable uniformity of structure and is so clearly bounded by other accumulations of known significance that its history is readily interpreted. From a detailed analysis of its laminated structure it is argued that this deposit was about 1700 years in accumulating.

A like interpretation of similar isolated deposits following the retreating ice-sheet would give data for time estimates from an entirely new standpoint. In some areas laminated clays occupy interglacial positions, and it may be possible to apply the same method to them.

The last paper of the evening was by Professor **Grabau,** on

the evolution of some Devonic spirifiers. *Spirifier mucronatus* (Conrad) is a Linnæan species comprising a large number of mutations. A remarkable fact is that all mutations pass through a mucronate type such as is characteristic of the typical mutation after which the species is named. (The term *mutation* is here used in the sense in which it was originally proposed by Waagen, and not in that in which it was subsequently used by De Vries; i.e., for the result and not for the process.) A still earlier stage in development (nepionic) shows the non-mucronate features of the ancestral species similar *to S. duodenarius* of the Onondaga. The mucronate feature is carried to excess in a number of mutations of the Lower Hamilton group. It is especially persistent in the Michigan region. This type of outline is accompanied by a rib in the median sinus and a depression in the fold. In Ontario the primitive mucronate type gives rise upward to a number of mutations which are especially characterized by progressive increase in height without corresponding lengthening of the hinge. The median plication and depression quickly disappear.

Acceleration and retardation in development are the chief principles which explain the development of the great number of mutations. For the principle of retardation the term *bradygenesis* (from βραδύς, slow,) was proposed, corresponding to the term *tachygenesis* proposed by Hyatt for acceleration.

In the New York province the primitive mucronate type gives rise to high and short-hinged mutations, but these retain the median rib and depression. In form these are tachygenetic; in respect to the surface features, bradygenetic. In the arenaceous beds of the later Hamilton in eastern New York, a mutation with many ribs and moderate mucronations exists. This is in many respects a bradygenetic type.

Side by side with extremely accelerated or tachygenetic types in all horizons (i.e., very short-hinged, non-mucronate, high and thick mutations) occur slightly retarded or bradygenetic types, which retain in the adult the mucronate character which is typical of the young of all the mutations.

A. W. Grabau,
Secretary.

SECTION OF BIOLOGY.

FEBRUARY 13, 1905.

Section met at 8.15 P.M., Professor Wheeler presiding.

The minutes of the last meeting were read and approved.

It was voted to postpone the program of the evening until the March meeting, to enable the members of the Section to attend a lecture by Professor Henry F. Osborn, on the "Evolution of the Horse," in the auditorium of the museum.

M. A. BIGELOW,
Secretary.

SECTION OF ANTHROPOLOGY AND PSYCHOLOGY.

FEBRUARY 27, 1905.

Section met at 8.20 P.M., General Wilson presiding.

The minutes of the last meeting of the Section were read and approved.

The following program was then offered:

Maurice Fishberg,	ANTHROPOMETRY OF THE JEWS OF NEW YORK.
R. S. Woodworth and **Frank G. Bruner,**	ANTHROPOMETRIC WORK AT THE ST. LOUIS EXPOSITION.

The Section met in conjunction with the American Ethnological Society.

SUMMARY OF PAPERS.

Dr. **Fishberg,** in an interesting paper, stated that whether the Jews have maintained their racial purity to the present day is a question that can be examined by comparing the physical type of Jew from different countries. Extensive measurements of Jewish immigrants in New York from various countries of Eastern Europe show that the Jewish type in those countries is not Semitic, but varies in the different countries, always approximating, in stature and cephalic index, to the native or Christian population of the respective countries.

Drs. **Woodworth** and **Bruner** said, As many as possible of the racial groups represented at the Exposition were measured The best material was found among the Philippine Islanders, of whom about 700 were measured. The Christianized tribes, such as the Tagalog, Pampango, Ilocano, Bicol, Visaya, were found very uniform in physical type. Measurements showed no clear evidence of differentiation among them. The average height of the several tribes differed but little from 161 cm., the cephalic index differs little from 83, etc. The Moros of Mindanao also are practically identical in physical type with the Christian tribes. The pagan Igorots and Bagobos seem to differ considerably from this type, especially in height, which is about 155 cm.; while the Negritos were clearly marked off from all the rest by their kinky hair, small stature (144 cm.), broad nose, and small head in proportion to stature.

R. S. WOODWORTH,
Secretary.

BUSINESS MEETING.

MARCH 6, 1905.

The Academy met at 8.15 P.M. at the American Museum of Natural History, President Kemp presiding.

The minutes of the last meeting were read and approved.

The following names were then presented for election as Active Members, having been recommended by the Council:

William A. Anthony	Cooper Union
Charles M. Bergstresser	60 West 47th Street
R. A. Canfield	Providence, R. I.
Banyer Clarkson	26 West 50th Street
Mrs. Farquhar Ferguson	20 West 38th Street
Mrs. Theodore Kane Gibbs	Newport, R. I.
James B. Hammond	205 West 57th Street
Arthur B. Heinze	220 Madison Avenue
George D. Hilyard	144 East 49th Street
Mrs. L. S. Hinchman	3635 Chestnut Street, Philadelphia, Pa.
Patrick Kiernan	14 East 83d St.

Bradley Martin (Life)	4 Chesterfield Gardens, Mayfair, London
Henry V. A. Parsell	770 West End Avenue
Mrs. Edwin Parsons	326 West 90th Street
Miss Frances Pell	206 Madison Avenue
William. H. Perkins (Life)	Park Avenue Hotel
Gifford Pinchot,	1615 Rhode Island Avenue, Washington, D.C.
Samuel Robert	906 Park Avenue
George J. Seabury,	59 Maiden Lane
Paul M. Warburg,	3 East 82d Street
Horace White,	18 West 69th Street

ASSOCIATE ACTIVE MEMBER

James, F. Wilton	257 West 12th Street

It was voted that the Secretary cast a unanimous ballot for the above candidates.

There being no further business, the meeting adjourned.

HERMON C. BUMPUS,
Recording Secretary.

SECTION OF GEOLOGY AND MINERALOGY.

MARCH 6, 1905.

Section met at 8.45 P.M., Professor Stevenson presiding.

The minutes of the last meeting of the Section were read and approved.

The following program was then offered:

E. P. Adams, ON THE ABSENCE OF HELIUM FROM CARNOTITE (by title).

F. Wilton James, NOTES ON THE MINNEWASKA REGION OF ULSTER COUNTY, N. Y.

A. A. Julien, DETERMINATION OF BRUCITE AS A ROCK-CONSTITUENT.

SUMMARY OF PAPERS.

Dr. **Adams's** paper was read by title.

The following brief account of his experiments was handed later to the Secretary:

"The experiments of Sir William Ramsay and Seddy on the formation of helium from the radium emanation account very readily for the well-known fact that the minerals which contain helium in appreciable quantity contain as well one or more of the radioactive elements. It might therefore be expected that all radioactive minerals should contain helium.

"I have recently been testing various specimens of carnotite to determine whether or not helium is present in them. Carnotite promises to become an important source of radium; certain specimens have been found which have a radioactivity 1.6 times that of the metallic uranium, although it appears to be difficult to obtain large quantities of mineral of this high activity. On heating *in vacuo* several grams of this carnotite, considerable quantities of carbon dioxide and water were driven off, and when these were absorbed by caustic potash and phosphorus pentoxide, respectively, only the nitrogen spectrum could be observed in a vacuum tube connected to the pump. No trace of helium could be detected, although no difficulty was found in obtaining the helium spectrum when only a tenth as much pitchblende, monazite sand, or thorianite[1] was used.

"The quantity of gas which was obtained from this amount of carnotite was so small that it was thought worth while to work with a larger quantity of the mineral. For this purpose 300 grams of carnotite, of activity 0.8 times metallic uranium, was heated at a red heat *in vacuo* for three hours, and after absorbing the carbon dioxide by caustic potash, about 10 c.c. of a gas remained. On sparking this, after adding oxygen, in order to absorb the nitrogen present, a rapid decrease in volume took place, and when finally the excess of oxygen was absorbed by means of phosphorus, only about 0.1 c.c. of a gas remained. This, when introduced into a spectrum tube, showed the characteristic red spectrum of argon. It was observed that the greater part of the gas, aside from the carbon dioxide, was given off on the first gentle heating; and it is

[1] The recently discovered mineral from Ceylon, containing about 75% of thorium, was kindly supplied by Dr. George F. Kunz for this purpose.

therefore probable that the argòn was associated with the air held in the powdered mineral which was completely driven off only upon heating it.

"It therefore appears that if helium is contained in carnotite at all, it exists in far smaller amount than would be expected from the quantity of radium present. But it is probable that this absence of helium may be explained by the physical properties of the mineral. Carnotite is a very fine powder which is usually found disseminated through sandstone. Now even the most compact specimens of this sandstone containing carnotite are quite permeable to gases. This was shown by closing one end of a glass tube with a piece of the mineral about 2 cm. in thickness, and filling it with illuminating gas over water. In a few minutes the water rose a distance of 6–7 cm. in the tube. If we then assume helium to be formed in this mineral by the disintegration of the radium it appears reasonable to suppose that it rapidly diffuses away. The minerals that contain helium are known to be massive, impervious substances, which are therefore able to retain the helium formed in them.

"This explanation of the absence of helium from carnotite appears to be supported by the views of Travers[1] on the state in which helium exists in minerals. According to him the helium is present in the minerals in a state of super-saturated solid solution; the minerals being impermeable to the gas at ordinary temperatures, the velocity with which equilibrium is established between the helium in solution and the helium in the gaseous phase is very small, but increases rapidly with rise of temperature. In the case of carnotite, however, the mineral is permeable to the gas at ordinary temperatures, and therefore we could not expect to find any appreciable amount of helium in this mineral."

Mr. **James** stated that the stripping of the grit from the crest of the second anticline of the Shawangunk Mountain (Darton, Rep. 47, N.Y. State Mus.) appears to be due to a slight cross fold by anticlinal fracture and erosion, as the rocks at the southwest end of the eroded area show an upward pitch.

[1] Nature, Jan. 12, 1905.

Through this depression the Peterskill probably flowed, while its own valley and Coxing Clove were dammed by the front of the ice sheet, and cut then the Paltz Gap in the crest of the first anticline, 200 feet deep, through which the road to New Paltz now runs.

The basin of Lake Minnewaska is vertically walled except at the southwest end. The cliffs are highest under Cliff House, where they stand 160 feet above the surface of the lake and 65 feet below it. The grit is probably about 230 feet thick here. The walls are pierced by four crevasses, now filled with drift,—the remains of two fissures crossing each other at the deepest point in the lake, which is there 74 feet deep. There is no drift in the lake basin, not even under the south-facing cliffs, although the fissure running S. 25° W. is filled, and the transverse breach is blocked to 150 feet above the lake. The glaciation is here S. 10° W. The cause of the absence of drift is not clear; elsewhere the cliffs are heavily skirted.

Lake Awosting lies along a vertical fault plane, drift-filled at both ends. The fault has not been studied. The north wall of the Palmaghat is a vertical fault of 200 feet throw. Both these faults seem to be derived from the overthrown anticline of the Coxingkill escarpment. Mr. Barton is in error in declaring the absence of extended faults.

Dr. **Julien,** after a brief review of the life of Dr. Archibald Bruce of New York City, the discoverer of brucite, discussed the fact of the wide distribution of the mineral, both in limestone and serpentinoids, either in its unchanged condition, or in the form of its derivatives, especially magnesite and hydromagnesite, as maintained by Volger in 1855.

The following are its most marked characteristics for recognition as a rock-constituent:

1. In addition to the known basal cleavage, two other systems may be distinguished on plates or folia: that of the hexagonal prism, often becoming rhombohedral, intersecting at 60° or 120°; and that of the hexagonal pyramid, intersecting at 90°.

2. Nemalitic structure or fibration, commonly occurring in brucite, within serpentinoids subjected to dynamic stresses.

The major axis of elasticity always lies parallel to the direction of the fibres.

3. Refractive Index, 1.57, sufficient, where the associated minerals are pure, to distinguish it by the Becke method from serpentine on the one hand, and from amphiboles, dolomite, etc., on the other.

4. Birefringence ($\gamma - \alpha = 0.020$), presenting interference colors of the upper First Order up to sky blue of the lower Second Order, in plates or sections of the usual thinness.

5. Characteristic strain phenomena; particularly by disturbance of the interference figure, examined by convergent light in basal cleavage plates of folia; also by a variable, small extinction angle in sections parallel to the vertical axis.

6. Optically positive character of the uniaxial figure, in distribution from talc, serpentine, etc.

7. Occasional twinning, observed in crystals enclosed in limestone.

8. Certain chemical tests, in confirmation of the optical diagnosis.

The meeting then adjourned.

A. W. GRABAU,
Secretary.

SECTION OF BIOLOGY.

MARCH 13, 1905.

Section met at 8.15 P.M., Vice-President Wheeler presiding.

The minutes of the last meeting of the Section were read and approved.

The following program was then offered:

L. I. Dublin, THE HISTORY OF THE GERM CELLS IN *Pedicellina americana.*

F. A. Lucas, WHALES AND WHALING ON THE COAST OF NEWFOUNDLAND (illustrated with lantern slides).

F. S. Lee, TEMPERATURE AND MUSCLE FATIGUE (illustrated with lantern slides).

SUMMARY OF PAPERS.

Mr. **Dublin** described the history of the germ-cells in *Pedicellina americana*, giving special attention to the chromatic changes. The somatic number of chromosomes is twenty-two. These bodies behave, throughout, very much as has been described by many workers on other forms; but in addition there has been observed a peculiar process in connection with the reduction of the chromosomes. These are V-shaped in the somatic cells and in the several generations of oogonia and spermatogonia with the exception of what appears to be the last. In this the number is still twenty-two, but they are bar-shaped. These divide and, either before or at the telophase, apparently unite end to end in pairs to form eleven new V's each bivalent as compared with the earlier structures. A longitudinal splitting of these loops, coincident with the extensive growth of the individuals, produces in the first maturation division eleven ring- or bar-shaped chromosomes, each of which is structurally a tetrad. The first division is thus reducing; the second equational. The change in chromosome form in the last oogonial and spermatogonial generations is then clearly a striking adaptation to the subsequent synapsis or reduction, making the latter easily possible.

Mr. **Lucas** gave an account of whales and whaling on the coast of Newfoundland, illustrating his remarks with stereopticon views of the whales and stages of their capture. Three species of whales were described: the finback, the humpback, and the sulphur-bottom, the first two being found on the south and east coast, the last one on the south coast only. The speaker then described the past and present methods of capture and utilization, saying that whales are now worked up so rapidly that within forty-eight hours after one is brought to the whaling station it is reduced to oil, fertilizer, and bone. The lecture closed with an interesting account of the method employed in making the mould of the large model of a whale shown by the National Museum in the exhibit at St. Louis. This was possibly the largest mould ever made, and the cast was the first accurate representation of a fully grown whale.

Professor **Lee** discussed temperature and muscle fatigue. He and others have previously pointed out that the contraction process of the muscles of cold-blooded animals in the course of fatigue becomes greatly slowed, while those of warm-blooded animals show no such phenomenon. Lohmann has recently claimed that a cold-blooded muscle on being heated to a mammalian temperature shows a course of fatigue similar to that of mammalian muscle; and, on the other hand, that a warm-blooded muscle on being cooled fatigues like the muscles of cold-blooded animals at a similar temperature. From these supposed effects he infers that in the matter of fatigue there is no real physiological difference between the two groups of muscle. Professor Lee has not been able to confirm Lohmann's conclusions. Every variety of muscle which has been tested, whether of cold-blooded or warm-blooded animals, shows its characteristic method of fatigue, whatever the temperature may be. The original conclusion regarding the difference between the two groups of muscles seems, therefore, to be justified.

M. A. Bigelow,
Secretary.

SECTION OF ASTRONOMY, PHYSICS, AND CHEMISTRY.

March 20, 1905.

Section met at 8.15 P. M., Vice-President von Nardroff presiding.

The minutes of the last meeting of the Section were read and approved.

The following program was then offered:

S. A. Mitchell, The Sixth Satellite of Jupiter.
E. R. von Nardroff, A Pocket Form of the Piezic Barometer.
George F. Kunz, Exhibition of the U.S. Geological Survey Radium Exhibit, which was Shown at the St. Louis Exposition.
L. G. Cole, Rectilinear Röntgen Rays.

SUMMARY OF PAPERS.

Dr. **Mitchell** gave an interesting account of the recent discovery of a sixth and also a seventh satellite of Jupiter by Professor C. D. Perrine at the Lick Observatory, and described the details of the photographic method by which these satellites were discovered last December and January.

Dr. Mitchell also spoke of the discoveries of satellites of the other planets, including the ninth satellite of Saturn, which was found by Professor W. H. Pickering in August, 1899.

Dr. **von Nardroff** defined the Piezic barometer as an instrument to measure the atmospheric pressure by measuring the elasticity of a portion of air. In the small pocket form of the instrument exhibited, a piece of heavy barometer tubing, of 3 mm. bore and about 12 cm. long, was provided at its lower end with a pear-shaped bulb, having an internal volume equivalent to about 70 cm. length of the tube. At its upper end the tube was provided with a second small bulb containing about 1 c.c. of mercury. Entering into the tube from above was a short tube having at its lower end a capillary opening. Through this tube the mercury was introduced.

In using the instrument all the mercury is brought into the upper bulb by inverting. The instrument is then turned into the erect postion, when the mercury enters the main tube a few centimeters, the exact distance depending upon the atmospheric pressure. The less the pressure, and hence the less the elasticity of the air, the more the mercury will enter. The mercury stands in the upper portion of the tube and partly in the upper bulb, without any tendency to run down the sides of the tube. A scale on the main tube drawn *by comparison* with a standard barometer indicates the pressure.

To understand the theory of the instrument assume the lower bulb replaced by a continuation of the barometer tubing of equal volume. Let b stand for the standard barometer height, m for the length of the thread of mercury entering the tube, and a for the length of the column of compressed air. Then from Boyle's law ($pv = p'v'$) we have

$$b(a + m) = (b + m) a,$$
$$b = a,$$

and hence

$$\Delta b = \Delta a.$$

That is, the divisions of the scale on the Piezic barometer are of the same size as those on the ordinary barometer. However, in practice the upper bulb always contains some mercury after the air is entrapped. The general effect of this is to make $\Delta a < \Delta b$.

Dr. **Kunz** described the object of and the success of the radium exhibit, stating that many of the most eminent investigators, including Sir William Crookes and Professor Rutherford, had sent their original material. The collection was shown in an upper hall of the museum. There was also exhibited the Kunz 1081-pound mass of Cañon Diablo meteoric iron, the largest mass known of this meteoric iron. Dr. Kunz stated that Professor Henri Moissan of Paris had discovered, in dissolving 183 pounds of this material (Cañon Diablo meteorite), not only crystalline diamonds, but the crystalline substance carbon silicide, never before discovered as a natural product, but extensively manufactured and used in the arts under the name of carborundum. In view of the many eminent discoveries of Professor Moissan in the field of chemistry and electro-metallurgy, as well as in the study of meteorites and of diamond formation, Dr. Kunz suggested that this mineral be named *moissanite* in his honor.

Dr. **Cole** in his paper said that the immediate discharge from an X-ray tube consists of two distinct classes of so-called rays—direct and indirect. The direct rays have their inception at the focal point of the anode and radiate in direct lines and are not reflected or deflected and do not set up secondary rays, but are absorbed by the tissue of the body in proportion to the amounts of solid contained therein.

The indirect rays radiate from the walls of the tube and are projected at various angles, causing secondary rays in objects with which they come in contact, especially the soft tissue, and give great penetration. The effect attained depends on the amount of current, frequency of interruption, and molecular action of glass.

Dr. Cole then described the life history of a tube, stating that definite changes occur in a tube when used, including a crisis, and explained the difference between the action of new and seasoned tubes and the difficulty of exciting very old tubes.

He also gave his opinion of the cause of the purple color of the glass of a tube and suggested that there is a molecular rearrangement of glass similar to that occurring in steel when magnetized. In a new tube the direct rays amount to 30 to 40 per cent., while in some seasoned tubes as much as 75 to 90 per cent. Furthermore the indirect rays project themselves behind the bones, causing a lack of definition of bones and obliteration of detail of soft parts, while direct rays give detail in soft parts, showing even the blood in the veins.

C. C. TROWBRIDGE,
Secretary.

SECTION OF ANTHROPOLOGY AND PSYCHOLOGY.

MARCH 27, 1905.

Section met in two sessions, at 2.30 and 8.15 P.M., at the Psychological Laboratory of Yale University, New Haven, Conn., in conjunction with the New York Section of the American Psychological Association, Vice-President F. J. E. Woodbridge presiding.

The minutes of the last meeting of the Section were read and approved.

The following program was then offered:

At the afternoon session:

Raymond Dodge, CENTRAL ANÆSTHESIA DURING EYE MOVEMENT.
Charles H. Judd, MOVEMENTS OF CONVERGENCE.
E. H. Cameron, VARIATIONS IN SUNG TONES.
F. Lyman Wells, PERCEPTION OF LINGUISTIC SOUNDS.
Naomi Norsworthy, MENTAL GROWTH IN DEFICIENT CHILDREN.

At the evening session:

Frank G. Bruner, RACIAL DIFFERENCES IN THE UPPER LIMIT OF AUDIBILITY.
G. Cutler Fracker, TRANSFERENCE OF PRACTICE.

J. McKeen Cattell,	PRACTICE AND TRAINING.
L. A. Weigle,	STUDIES IN READING ALOUD.
W. L. Sheldon,	CHANCE.
W. P. Montague,	TYPES OF MONISM.

No abstracts of these papers have been received.

R. S. WOODWORTH,
Secretary.

BUSINESS MEETING.

APRIL 3, 1905.

The Academy met at 8.15 P.M., at the American Museum of Natural History, President Kemp presiding.

The minutes of the last meeting were read and approved.

The following names were then presented for election as Active Members, having been recommended by the Council:

Francis J. Arend	32 West 73d Street
S. T. Armstrong, M.D.	141 Broadway
S. P. Avery, Jr.	4 East 38th St.
H. R. Bishop	36 East 62d Street
Zenas Crane (Life)	Dalton, Mass.
H. L. Dougherty	Engineers' Club, N.Y. City
George E. Dunscombe (Life)	392 Canal Street
Rev. M. E. Dwight	31 Mt. Morris Park West
Ad. Engler	437 West 23d Street
Charles S. Fairchild	10 West 8th Street
Ernest F. Greeff	37 West 88th Street
William Guggenheim	833 Fifth Avenue
E. H. Harriman	1 East 55th Street
Dr. Louis Haupt	232 East 19th Street
Selmar Hess	956 Madison Avenue
George B. Hopkins (Life)	25 West 48th St.
Thomas H. Hubbard (Life)	16 West 53d Street
Archer M. Huntington (Life)	"Pleasance," Baychester, N.Y. City
Walter R. T. Jones	51 Wall Street
John B. Lawrence	126 East 30th Street
Marshall C. Lefferts	34 East 65th Street

Alfred LeRoy,	117 Wall Street
James Loeb (Life)	Shrewsbury, N.J.
Walter Lüttgen	Linden, N. J.
Robert F. Mager	423 West 147th Street
William Church Osborn	71 Broadway
Henry Parish	52 Wall Street
H. F. Poggenburg	111 East 69th Street
Henry W. Poor	1 Lexington Ave.
M. Taylor Pyne (Life)	Princeton, N.J.
Samuel Riker	27 East 69th Street
Miss Jane E. Schmelzel	16 West 56th Street
Mrs. Cynthia A. Wood	117 West 58th Street

It was voted that the Assistant Secretary cast a unanimous ballot for the above candidates.

There being no further business the meeting adjourned.

HERMON C. BUMPUS,
Recording Secretary.

SECTION OF GEOLOGY AND MINERALOGY.

APRIL 3, 1905.

Section met at 8.30 P.M., Professor Stevenson presiding.

The minutes of the last meeting of the Section were read and approved.

The following program was then offered:

James F. Kemp, PHYSIOGRAPHY OF THE ADIRONDACKS (with lantern illustrations and map).

Charles P. Berkey, PALÆOGRAPHY OF NORTH AMERICA DURING MID-ORDOVICIC TIME (illustrated by maps, diagrams and lantern views).

George F. Kunz, EXHIBITION OF PHOTOGRAPHS OF MOISSANITE CRYSTALS SENT BY PROFESSOR MOISSAN.

SUMMARY OF PAPERS.

Professor **Kemp** discussed the physiography of the Adirondacks as follows:

The Adirondacks cover some 10,000 square miles, and, except for the White Mountains of New Hampshire and the Blue Ridge of North Carolina, are the loftiest summits east of the Black Hills of South Dakota. They are metamorphosed Precambrian sediments and eruptives with a surrounding fringe of Paleozoics, beginning with the Potsdam and ending with the Utica, except for the Glacial drift. The eastern portion is mountainous, the western a high plateau which slopes to Lake Ontario. Three peaks exceed 5000 feet. The general profile of the mountains is serrate, but there is great variety of shape.

There are two contrasted types of valleys. One, doubtless an instance of great geological antiquity, presents gentle slopes and great maturity of form. Its members run east and west, and north and south, and are occupied in some cases by the larger lakes.

The second type is more recent, and is due to faulting. The valleys have on one or both sides precipitous escarpments. The cliffs run northeast and southwest or northwest and southeast. A third series of breaks running nearly due north is also at times in evidence. The faults are most often the result of differential movements causing even a marked sheeting of the rocks. The faults run out into the Paleozoic areas, and are shown with diagrammatic distinctness, where they have been especially described by H. P. Cushing.

The problem of the drainage is of especial interest. All the waters go ultimately either to the Hudson or the St. Lawrence. The courses of the large streams follow sometimes the older type of valleys, sometimes the later. Barriers of drift have often driven them from their old lines across low, preglacial divides into new ones. The courses of the Hudson and Sacondaga are particularly striking illustrations, each exhibiting one or more marked bends to the eastward. The courses of the two were described and discussed in some detail.

The different types of lakes were also described, including the ponded river valleys from barriers of drift; the fault valleys; and the relations to the older type of depression.

The nature of the ice invasion and its modifying effects were

passed in review, chiefly along the work of I. H. Ogilvie. With a brief statement of the postglacial lake-fillings, etc., which have been especially set forth by C. H. Smyth, Jr., the paper closed.

A brief discussion followed.

Dr. **Berkey** said that both Cambric and Ordovicic strata contain prominent sandstone formations alternating with dolomites wherever exposed in Michigan, Minnesota, Wisconsin, Iowa, Illinois, Missouri, Arkansas, and Indian Territory. The northern margin, however, is prevailingly more arenaceous than the southern, where shales replace many sand beds. At still greater distance, in Ohio, Kentucky, and Tennessee, these are in turn represented by limestones largely.

The uppermost one of the series is the St. Peter. This sandstone, as well as each of the more important ones below, is believed to represent an extensive retreat and readvance of the sea. Few marks of the erosion interval are preserved. Only here and there has the mantle of sand permitted much attack upon the underlying dolomite, and the reworking of the sands themselves has obliterated most internal evidence of such history.

Much of the sand, furthermore, is wind-blown. The reworking by the sea and the wind is believed to be the chief cause of the extreme purity of the St. Peter.

The St. Peter stage of the Ordovicic, therefore, represents a retreat of the Mississippian Sea from the vicinity of Lake Superior to probably as far as Ohio, southern Illinois, and Arkansas, followed by a readvance to nearly its original position. The northern part of the St. Peter contains within itself therefore a sedimentary break. In part it is both older and younger than the same formation in its southern extension, while, on account of the reworking accompanying the sea advance. there is greater conformity with overlying than with underlying beds.

Dr. Berkey's paper was followed by a brief discussion, after which the Section adjourned.

A. W. GRABAU,
Secretary.

SECTION OF BIOLOGY.

April 10, 1905.

Section met at 8.15 P.M., Vice-President Wheeler presiding.

The minutes of the last meeting of the Section were read and approved.

The following program was then offered:

H. F. Osborn, The Ideas and Terms of Modern Philosophical Anatomy.

O. P. Hay, The Turtles of the Bridger Basin.

Summary of Papers.

The abstract of Professor **Osborn's** paper will be published under its own title in *Science.*

Dr. **Hay** gave a brief description of the extent of the Bridger beds and of the nature of the materials composing them. He expressed the conviction that these deposits had not been made in a lake, but over the flood-grounds of rivers. The region was probably covered with forests, and teemed with animal life. In the streams were numerous turtles. Many species of these have been described by Dr. Leidy and Professor Cope. In the speaker's hands are materials for the description of about a dozen more species. The American Museum party of 1903 collected many specimens of the genus and these have furnished good skulls, neck, shoulder, and pelvic girdles, and the limbs. These materials confirm the validity of Lydekker's group called Amphichelydia, and show that from it sprang the modern superfamilies Cryptodira and Pleurodira.

M. A. Bigelow,
Secretary.

SECTION OF ASTRONOMY, PHYSICS, AND CHEMISTRY.

April 17, 1905.

Section met at 8.15 P.M., Vice-President von Nardroff presiding.

The minutes of the last meeting of the Section were read and approved.

The following program was then offered:

S. A. Mitchell, PURPOSES AND PLANS OF THE SOLAR ECLIPSE EXPEDITIONS OF AUGUST, 1905.

C. C. Trowbridge, VARIATIONS IN THE DURATION OF THE AFTER-GLOW, PRODUCED BY CHANGES OF POTENTIAL, AND FREQUENCY OF OSCILLATION OF THE DISCHARGE.

No abstracts of these papers have been received.

CHARLES C. TROWBRIDGE,
Secretary.

SECTION OF ANTHROPOLOGY AND PSYCHOLOGY.

APRIL 26, 1905.

Section met at 8.15 P.M., Vice-President Woodbridge presiding.

The minutes of the last meeting of the Section were read and approved.

The following program was then offered:

Berthold Laufer, THE RELATION OF CHINA TO THE PHILIPPINE ISLANDS.

William Jones, THE RELIGIOUS CONCEPTION OF THE MANITOU OF THE CENTRAL ALGONKINS.

George H. Pepper, SYMBOLIC DESIGNS ON THE INDIAN TEXTILES OF THE SOUTHWEST.

Harlan I. Smith, STONE SCULPTURES AND IMPLEMENTS FROM THE LOWER COLUMBIA VALLEY.

The Section met in conjunction with the American Ethnological Society.

No abstracts of these papers have been received.

R. S. WOODWORTH,
Secretary.

BUSINESS MEETING.

MAY 1, 1905.

The Academy met at 8.15 P.M., at the American Museum of Natural History, President Kemp presiding.

The minutes of the last meeting were read and approved.

The following names were then presented for election as Active Members, having been approved by the Council:

Edwin H. Brown	Wantagh, L.I.
H. A. DuPont	Winterthur, Delaware
Dr. Samuel M. Evans	115 East 39th Street
Robert Hoe, Jr.	21 Mt. Morris Park
Francis T. Maxwell	Rockville, Conn.
Herman A. Metz	253 Clinton Avenue, Brooklyn
Lewis R. Morris	155 West 58th Street

ASSOCIATE ACTIVE MEMBERS

Thomas C. Brown	Columbia University
Clarence E. Gordon	Columbia University

It was voted that the Assistant Secretary cast a unanimous ballot for the above candidates.

The Academy then adjourned.

HERMON C. BUMPUS,
Recording Secretary.

SECTION OF GEOLOGY AND MINERALOGY.

MAY 1, 1905.

Section met at 8.30 P.M., Vice-President Hovey presiding.

The minutes of the last meeting of the Section were read and approved.

The following program was then offered:

J. Howard Wilson, THE PLEISTOCENE BEDS OF SANKATY HEAD, NANTUCKET.

C. E. Gordon, EARLY STAGES OF SOME PALÆOZOIC CORALS.

Thomas C. Brown, A NEW TERTIARY FAUNA FROM THE ATLANTIC COAST PROVINCE.

C. A. Hartnagel, STRUCTURAL RELATIONS AND ORIGIN OF THE LIMONITE BEDS AT CORNWALL, N.Y.

A. W. Grabau, TYPES OF SEDIMENTARY OVERLAP.

SUMMARY OF PAPERS.

Mr. **Wilson,** in his paper, said that when Sankaty Head, Nantucket, was first visited by early explorers the section at that locality was kept freshly exposed by the cutting back of the bluff by the sea, but for quite a period of years this has

been prevented by the northward extension of the Siasconset apron beach, so that the face of the bluff is now covered with talus and overgrown with beach grass.

The locality was visited during the summer of 1904, and considerable work done in exposing the section and making a collection of the fossils.

This work resulted in the collection of eighty-one species, twenty-one of which had never been reported from this point, including *Pandora crassidens* Conrad, not previously found in any horizon above the Miocene, and *Serrepes laperousii* Deshayes and *Macoma incongrua* von Martens, belonging to the Arctic fauna of the Pacific coast and not heretofore reported east of Point Barrow.

A number of facts differing somewhat from those reported by former observers were noticed, and have resulted in a somewhat different interpretation for the phenomena presented by these deposits.

The deposits are not of glacial origin, for—1. Numerous delicate and unworn shells occur. 2. Bivalves such as *Solen*, *Venus*, and *Mya* occur in the position in which they lived, with both valves together, and in the case of Venus with the ligament in place. 3. The faunas are not mixed as would be the case if of glacial origin, the lower beds containing shoal water species of a southern range, and the upper, deeper water species of a northern and even Arctic type.

The lower beds were deposited in a shallow inlet or lagoon, as shown by such species as *Mya*, *Ostrea*, and *Venus* and especially by numerous mud crabs and the presence of our edible crab, *Callinectes sapidus*, while the upper beds were deposited during a subsidence of the area contemporaneous with the advance of the Wisconsin ice sheet, as shown by the deeper water and more northern species.

After the destruction and washing into the lagoon of the protecting barrier beach, as shown by the overlying rounded and pure white sands, the ice reached and passed this point, eventually burying the beds under fifty feet or more of drift. Later, a re-elevation took place, bringing the land to about its present position.

Mr. **Gordon** stated that J. E. Duerden, in the Johns Hopkins University Circular for 1902, has endeavored to show by studies based on *Lophophyllum proliferum* that the Rugosa exhibit a hexameral plan of growth of the primary septa, in so far as *L. proliferum* may be taken as representative. Certain studies on *Streptelasma profundum* show a primary tetrameral plan. The fact that *S. profundum* is a middle Ordovicic type indicates that this is the primitive condition. Moreover, a careful examination of Duerden's figures shows that they lend themselves to an entirely different interpretation from that which Duerden gives. This interpretation is that two of the so-called primary septa are secondary septa precociously developed; that their sequence and ultimate position are the same as those for the secondary septa which appear in the corresponding positions in the corresponding quadrants of a Zaphrentoid coral; that the fossula and cardinal septum are on the concave side of the corallum; and that if Duerden's figures be inverted they reveal a perfect similarity to a Zaphrentoid coral, as far as the order of appearance and the arrangement of the septa are concerned.

The fact that *L. proliferum* is a Carbonic type indicates that it is a modified type of the Zaphrentoid coral, the first secondary septa appearing in nepionic stages and thus simulating the character of primary septa.

Mr. **Brown** stated that a few years ago, while studying the Cretacic deposits of Long Island, Block Island, and Martha's Vineyard, Dr. Hollick of the New York Botanical Garden made a collection of fossil molluscs and plants from Chappaquiddick Island. The fossil molluscs were deposited in the Columbia University collection without being fully and carefully studied.

These fossils occur in the island in ferruginous concretions. They seem to have been deposited somewhere to the north of where they are now found, then moved as glacial drift, reassorted and deposited in their present position. From their lithological similarity to concretions containing undoubted Cretacic fossils found elsewhere on Martha's Vineyard, Dr. Hollick thought that these concretions and their contained fossils must be of Cretacic age.

Professor Shaler in his geological studies of Martha's Vineyard noted the occurrence of these concretions and their similarities to the Cretacic drift, but being unable to find any distinctive organic remains hesitated to set them down as Cretacic.

Dr. Hollick submitted these fossil molluscs to Professor R. P. Whitfield of the American Museum of Natural History for a hasty examination. Professor Whitfield, after placing several of the fossils generically, stated that from their evidence he should think the rocks could hardly prove to be Cretacic.

A careful study of the fossils has shown that this material is not Cretacic but Eocene in age. This fauna from Chappaquiddick represents a new and distinct Eocene province, differing from all the other Eocene provinces of the Atlantic coast, but no more widely different from these than they are from one another. Although in this fauna there are several species somewhat resembling those of the provinces to the south, on the whole it would seem to be more closely allied to the Eocene of England. The genera most abundantly represented in these Chappaquiddick deposits, e.g., *Modiola*, *Glycymeris*, are also among the most abundant in the English deposits. These same genera, although represented in the Atlantic and Gulf provinces, are there more sparsely distributed and occur with other more abundantly represented genera that appear to be altogether wanting in the Chappaquiddick deposits.

A comparison of this Chappaquiddick fauna with other Eocene faunas indicates that it is of lower Eocene age, the species most closely resembling those found in this fauna being found in the lower beds of the Atlantic and Gulf provinces, the Tejon of California and the lower beds of England. These deposits may possibly be of the same age as the Shark River beds of New Jersey, but being deposited in a region separated from this have no forms in common with it. But such correlation could be only conjecture. As the correlation of the well-known Eocene deposits is even yet very uncertain it is unnecessary and impossible to place these beds any more definitely than simply to say that they are Lower Eocene.

Mr. **Hartnagel's** paper stated that the limonite at the Townsend iron mine near Cornwall in Orange county, New York, is

found at the base of the New Scotland beds, where the latter are in contact with the Longwood and shales. The source of the iron is evidently from the red shales, but whether the contact was due to overlap or faulting has not been previously explained. Two thirds of a mile north of the mine the Decker Ferry, Cobleskill, Rondout, Manlius and Coeymans formations, having a total thickness of ninety-five feet, are found between the New Scotland and Longwood beds. In the region of the mine the strata are nearly vertical, and in faulting a wedge-shaped block has been forced up, bringing the red shales in contact with the New Scotland beds. A cap of limestone has until recent geologic times protected from erosion the mass of soft Longwood shales, which now form a steep hill that is rapidly being worn away.

In discussing types of sedimentary overlap, Dr. **Grabau** said that with a normal sea-shore a rising sea-level will produce the phenomenon of progressive overlap, a falling sea-level that of regressive overlap. If the sea transgresses slowly, and the rate of supply of detritus is uniform, a basal rudyte or arenyte is formed which rises in the column as the sea advances, and whose depositional off-shore equivalents are successive beds of lutytes or organic deposits (biogenics). Types of such basal beds which pass diagonally across the time scale are seen in the basal Cambric arenytes of eastern North America, which as the Vermont Quartzyte are Lower Cambric, and as the Potsdam are Upper Cambric. Again in the basal Cretacic arenyte of southwestern United States, this is shown, they being basal Trinity in Texas, Washita in Kansas, and Dakota or later on the Front Range. Examples of this type of progressive overlap are numerous and familiar. On an ancient pemeplain surface the transgressing sea may spread a basal black shale, as in the case of the Eureka (Noel) Black shale, which is basal Choteau in southern Missouri and basal Burlington in northern Arkansas. Regressive movements of the shore succeeded by transgressive movements give us arenytes which are enclosed in off-shore sediments and which within themselves comprise an hiatus the magnitude of which diminishes progressively away from the shore. An example of this has

recently been discussed by Berkey,[1] who finds that the St. Peter Sandstone in Minnesota marks the interval from lower Beekmantown to upper Stones River, which interval is represented by several thousand feet of calcareous sediments in other regions distant from the shore of that time.

In marine transgressive overlaps, later members overlap earlier ones toward the source of supply, i.e., towards the oldland. In non-marine progressive overlaps, later members overlap the earlier ones away from the source of supply. Thus in a growing alluvial cone, the later formed beds will extend farther out on to the plain away from the mountain. If several successive fans of this type are formed one above the other, owing to successive elevations of the source of supply, only the latest beds of each delta will be found on the outer edge of this compound delta, the hiatus between the beds being further emphasized by the erosion which the last bed of the first delta underwent during the time that the early beds of the sccond delta were deposited nearer the source of supply, i.e., before the last bed of the second delta covered up the remnant of the last bed of the first delta and thus protected it from further erosion. A good example of this type of overlap appears to be presented by the Pocono, Mauch Chunk, and Pottsville beds of the Appalachian region. These formations are, with exception of the negligible Greenbrier member, of non-marine origin, representing the wash from the growing Appalachians. In western Pennsylvania only the latest beds of each (barring portions removed by erosion between the deposition of the successive fans) are found resting one upon the other, the interval between the beds becoming less and less toward the anthracite regions.

A. W. GRABAU,
Secretary.

SECTION OF BIOLOGY.

MAY 8, 1905.

Section met at 8.15 P.M., Vice-President Wheeler presiding.

[1] See *ante*, p. 591, April meeting.

The minutes of the last meeting of the Section were read and approved.

The following program was then offered:

E. B. Wilson, OBSERVATIONS ON THE CHROMOSOMES IN HEMIPTERA.

H. E. Crampton, CORRELATION AND SELECTION.

SUMMARY OF PAPERS.

Professor **Wilson's** paper presented the results of an examination of the mode of distribution of the chromosomes to the spermatozoa in *Lygæus turcicus*, *Cœnus delius*, *Podisus spinosus* and two species of *Euchistus*. In none of these forms is an accessory chromosome (in the ordinary sense) present, all of the spermatozoa receiving the same number of chromosomes, which is one half the spermatogonial number (the latter number is in *Podisus* sixteen, in the other forms fourteen). In all these forms, however, an asymmetry of distribution occurs such that two classes of spermatozoa are formed in equal numbers, both receiving a ring of six chromosomes (in *Podisus* seven) that are duplicated in all the spermatozoa, and in addition a central one which in one half the spermatozoa is much smaller than in the other half. These corresponding but unequal chromosomes (which evidently correspond to some of the forms described by Montgomery as "chromatin nucleoli" and agree in mode of distribution with that which this author has described in the case of *Euchistus tristigmus*) may be called the "idiochromosomes." They always remain separate in the first division, which accordingly shows one more than one half the spermatogonial number of chromosomes, but at the close of this division conjugate to form an asymmetrical dyad, the number of separate chromatin-elements being thus reduced from eight to seven (in *Podisus* from nine to eight). A reduction of the number to seven in the first division, such as has been described by Montgomery as an occasional or usual process in *Euchistus* and *Cœnus*, was never observed. In the second division the asymmetrical idiochromosome-dyad separates into its unequal constituents, while the other dyads divide symmetrically.

One half the spermatozoa, therefore, receive the large idiochromosome and one half the small, the other chromosomes being exactly duplicated in both.

Correlated with this asymmetry of distribution is the fact that the spermatogonial chromosome-groups do not show two equal microchromosomes (as is the case in such forms as *Anasa*, *Alydus* or *Protenor*, where an accessory chromosome is present); but only one, which is obviously the small idiochromosome, the large one not being certainly distinguishable at this period from the other spermatagonial chromosomes. The final synapsis of the idiochromosomes is deferred to the prophases of the second division, somewhat as that of the two equal microchromosomes is deferred until the prophase of the first division in *Anasa*, *Alydus* and some other forms. A remarkable result of the difference in this regard between the forms that possess and those that lack a true accessory chromosome is that in the former case (*Anasa*, *Alydus*, etc.) the first division of the small central chromosome is a reduction-division and the second an equation-division; while in the latter case (*Lygæus*, *Cœnus*, etc.) the reverse order manifestly occurs. The relation of these observations to earlier ones by Paulmier, Montgomery, and others was pointed out, with a discussion of their bearing on the Mendelian phenomena of heredity and the problem of sex-determination.

Professor **Crampton** presented briefly some of the conclusions drawn from the results of his work upon variation, correlation, and selection among saturnid lepidoptera. The earliest studies showed that eliminated individuals, when compared with similar members of the same group that survive, prove to be more variable and of somewhat different types, although this relation between variability and selection is not a constant one. The characters utilized for these preliminary studies, namely, certain pupal dimensions and proportions, were of such a nature that they could not serve the pupa directly in any functional manner; wherefore it was concluded that their condition of correlation formed the actual basis for the selective process, formative correlation being also distinguished from functional correlation. That the general condition of corre-

lation among the structural characters of pupæ formed, indeed, the basis for selection was further indicated by the results of a statistical study of the correlations between various characteristics of pupal groups from several different animal series; although an advantage did not always appear in favor of the surviving group. On the basis of the foregoing, a general theoretical conception was developed, according to which the whole series of internal elements and the whole series of external influences were regarded as involved in the determination of the general condition of correlation or co-ordination that formed the basis for selection, as adaptive or the reverse.

M. A. BIGELOW,
Secretary.

SECTION OF ASTRONOMY, PHYSICS, AND CHEMISTRY.

MAY 15, 1905.

Section met at 8.15 P.M., Vice-President von Nardroff presiding.

The minutes of the last meeting of the Section were read and approved.

The following program was then offered:

I. L. Tufts, RELATION BETWEEN IONIZATION AND COMBUSTION IN FLAMES.

L. L. Hendren, RATE OF RECOMBINATION OF GASEOUS IONS AT LOW PRESSURES.

No abstracts of the above papers have been received.

CHARLES C. TROWBRIDGE,
Secretary.

BUSINESS MEETING.

OCTOBER 9, 1905.

The Academy met at 8.15 P.M., at the American Museum of Natural History, President Kemp presiding.

The minutes of the last meeting were read and approved.

The following names were then presented for election as Active Members, having been recommended by the Council:

Elizabeth Billings	279 Madison Avenue
May Cline	Harmony, N.J.
Guy W. Culgin	133 West 129th Street
C. Temple Emmet	Stony Brook, L.I.
Alfred Taggart Millroy	53 Guilford Street, London, W.C.
Henry Clay Pierce	Waldorf-Astoria
A. M. Fernandez Ybarra,	314 Second Avenue

ASSOCIATE ACTIVE MEMBERS

Roland M. Harper	College Point, N.Y.
A. E. Stevenson	568 West End Avenue

It was voted that the Assistant Secretary cast a unanimous ballot for the above candidates.

There being no further business, the meeting adjourned.

HERMON C. BUMPUS,
Recording Secretary.

SECTION OF GEOLOGY AND MINERALOGY.

OCTOBER 9, 1905.

Section met at 8.15 P.M., Vice-President Hovey presiding.

The minutes of the last meeting of the Section were read and approved.

A public lecture was then delivered by Professor **Robert T. Hill**, on "THE REPUBLIC OF MEXICO; ITS PHYSICAL AND ECONOMIC ASPECTS."

The meeting was held in the large lecture hall of the American Museum of Natural History. Three hundred and seventy-one members and visitors were present. The lecture was fully illustrated with stereopticon views.

No abstract of this lecture has been received.

A. W. GRABAU,
Secretary.

SECTION OF BIOLOGY.

OCTOBER 16, 1905.

Section met at 8.15 P.M. at the American Museum of Natural History, Vice-President Wheeler presiding.

The minutes of the preceding meeting of the Section were read and approved.

The evening was devoted to reports of summer work carried on by members of the Section.

Summary of Papers.

Professor **H. F. Osborn** went to British Columbia to study the habits of mountain goats; he found large numbers of the animals and had many opportunities of studying and photographing them at close range. Dr. **Hay** studied certain fossil turtles in the American Museum of Natural History. Dr. **E. F. Byrnes** continued her study of variations in the crustacean *Cyclops*. She also gave some attention to regeneration in sense organs in *Nereis*. Dr. **H. R. Linville** worked at San Diego, Calif., studying the mechanics of circulation in *Nereis*. Professor **F. B. Sumner** directed the summer session at the United States Fisheries Laboratory at Woods Holl. He also completed his studies of the effect of density and salinity of water on fishes. Professor **Wheeler** continued his studies of ants and made out many interesting points on the formation of ant colonies by solitary queens.

M. A. Bigelow,
Secretary.

SECTION OF ASTRONOMY, PHYSICS, AND CHEMISTRY.

October 23, 1905.

Section met at 8.15, at the American Museum of Natural History, Vice-President von Nardroff presiding.

The minutes of the previous meeting of the Section were read and approved.

The evening was devoted to reports on summer work by members.

The meeting then adjourned.

C. C. Trowbridge,
Secretary.

SECTION OF ANTHROPOLOGY AND PSYCHOLOGY.

OCTOBER 30, 1905.

Section met at 8.15 P.M., at the American Museum of Natural History, Vice-President Woodbridge presiding.

The minutes of the preceding meeting of the Section were read and approved.

The following program was then offered:

Edgar L. Hewett, THE LIFE AND CULTURE OF THE TEWA INDIANS IN PRE-SPANISH TIMES.

The Section met in conjunction with the American Ethnological Society.

No abstract of the above paper has been received.

R. S. WOODWORTH,
Secretary.

BUSINESS MEETING.

NOVEMBER 6, 1905.

The Academy met at 8.15 P.M., at the American Museum of Natural History, President Kemp presiding.

The minutes of the last meeting were read and approved.

The following name was then presented for election as Active Member, having been recommended by the Council:

Reno B. Welbourn	Union City, Ind.

ASSOCIATE ACTIVE MEMBERS

Edward K. Judd	505 Pearl Street
Matthew van Siclen	Columbia University

By vote of the Academy, the candidates were unanimously elected.

Vice-President Hovey made the announcement of the recent death of Baron Ferdinand von Richthoven, Professor of Geography in the Imperial University of Berlin.

The meeting then adjourned.

HERMON C. BUMPUS,
Recording Secretary.

SECTION OF GEOLOGY AND MINERALOGY.

NOVEMBER 6, 1905.

Section met at 8.30 P.M., Vice-President Hovey presiding.

The minutes of the last meeting of the Section were read and approved.

The following sectional officers were nominated for the year 1906:

Vice-President and Chairman of Section, E. O. Hovey.

Secretary of Section, A. W. Grabau.

The following program was then offered:

J. F. Kemp, RECENT INTERESTING DISCOVERY OF HUMAN IMPLEMENTS IN AN ABANDONED RIVER CHANNEL IN SOUTHERN OREGON.

J. J. Stevenson, A BIT OF QUATERNARY GEOLOGY.

A. A. Julien, NOTES ON THE GLACIATION OF MANHATTAN ISLAND.

The papers were briefly discussed.

Dr. **George F. Kunz** announced the finding of pyrope and serpentine in the tunnel under New York Harbor. These indicated the presence of a peridotite dyke.

SUMMARY OF PAPERS.

During July and August, 1905, Professor **Kemp** was in the field in southern Oregon under the direction of Dr. David T. Day, chief of the Division of Mineral Statistics of the U. S. Geological Survey. The work assigned was the collection of black sands and crude gravels from the placer mines of this section for the experimental concentrating plant of the Survey at the Portland exposition. While visiting Waldo, Oregon, the following occurrence of human implements in the gravels of the Deep Gravel Mining Co. was met, and, with the permission of the Director of the Survey, is herewith communicated.

Waldo is situated on the stage line from Grant's Pass on the Southern Pacific R. R., 100 miles south of west from Crescent City on the coast in California, and is forty miles from Grant's Pass. It is in Josephine County, a few miles north of the California line.

Waldo was the scene of the earliest discovery in Oregon of stream placers in the country back from the ocean. Sailors penetrated to it in 1853 and found rich pay-streaks in the bed of a small stream which heads up in the ancient gravels of what must once have been a large river. The discovery received the name of the Sailor Diggings, and the name Waldo came later. The ancient gravels are now on top of a ridge and have remained in relief while the former banks have been removed by erosion. The course of the river was to the north, since its bed-rock declines in this direction. The bed-rock as exposed in the placer mines is chiefly serpentine, but in one place the rim-rock is fossiliferous sandstone, which has been studied and determined by J. S. Diller. The boulders are chiefly eruptive rocks of various sorts and are much softened as a rule by decomposition. The exact relations of the old drainage would require more investigation for their elucidation than the writer could give in the brief time at command, and it can only be stated that they cover a rather wide area east and west, having been mined at intervals for half a mile or more across the main course, but whether this is from forking of the old main channel or not was not determined. Some shallower gravels are probably due to the washing down of the old high-channel deposit over the slopes and on to the flats on either side of its crest.

Pestles appear to occur in the gravels as a not specially exceptional phenomenon. The operators of the mines speak of their occasional discovery as a matter which does not excite surprise. The following instance, however, of two mortars and of one or two pestles attracted the attention of Mr. W. J. Wimer, the manager and part owner of the Deep Gravel property, and, although the objects were brought to light in the hydraulicking during the night shift, he carefully recorded the details early the next morning. I particularly inquired about the possibility of the bank's caving in so as to make implements from the surface appear as if buried in the deeper gravels, but this possibility seems to be guarded against both by the auriferous cement in the larger mortar and by its actual detection in the bank by the pipe man. The mortar was thought by him to be a boulder and he shut off the stream and extracted it with

a pick. The mortars and pestles are now in the possession of Col. T. Waln-Morgan Draper, a well-known mining engineer, at whose summer home, a few miles from Waldo, the implements now are.

The following extract from a letter of Mr. Wimer written at my request gives the facts.

"The mortar is about 12 inches high by 9 inches across, and it is made of the hardest granite. Two of our night men piped it out in 1902, when it was firmly embedded in a blue cement gravel (the pay channel), fifty-eight feet from the surface. They had to resort to picks to get it out and the bed or hole out of which they pulled it remained, showing its perfect mould. I went to the mine in the morning and the two men formally presented it to me. It was still packed tightly to its very rim with blue cement gravel. With a sharp pick I carefully picked the gravel loose so that I could clean it. I was some time doing so. I then washed the detritus and got eight pretty large colors of gold.

"H. M. Pfefferly and D. W. Yarbrough were the finders. The place was in the S.W. 1/4 of N.W. 1/4; Sec. 21; T. 40 S.: R. 8. W., W.M., Josephine County, Oregon, on the property of the Deep Gravel Mining Co. The other mortar is what Colonel Draper terms a quartz mortar, having a saucer-like cavity on its top. The gold from the ground where it was piped out was pronounced by the Selby Smelting Company in San Francisco to be 'quartz gold,' their receipt to us being so marked. This mortar was probably about ten feet under the surface. It was 300 yards from the other one and on Sec. 20, being therefore the S.E. 1/4 of N.E. It was found in 1901. The pestles were discovered with it; they were in the pay dirt."

Those occurrences add one more instance to the list of stone implements which have been found in the auriferous gravels of the Pacific coast. The writer fully realizes the criticism which has been brought to bear upon them and the skepticism with which their authenticity is regarded by many. The Waldo case may be stated upon the testimony of Mr. Wimer and Mr. Pfefferly, and may add its contribution to the general mass of evidence regardng the antiquity of man in the Far West.

Professor **Stevenson** described a small area in northwestern Vermont. His conclusions were that, after withdrawal of the ice, clay was deposited along the streams to an altitude of about 750 feet above tide; that upon this sand, gravel, and boulders accumulated to a thickness of about 450 feet. He traced the steps in re-erosion of the channel ways as shown by the successive terraces. The area in question is the northward extension of Professor C. H. Hitchcock's third basin of Winoiski River as defined in the *Geology of Vermont*.

In the third paper of the evening Dr. **Julien** said the evidences of plucking action of the continental glacier upon the crystalline schists of the island consist partly of jagged broken surfaces beneath the till, with angular transported blocks in the moraine to the southwest; and partly of rounded but roughened hummocks, pitted apparently by a modification of semilunar cavities, such as have been discovered in perfect condition on scored surfaces of our limestone.

Channels and pipe-like troughs were also described and attributed to the action of subglacial running waters, probably once connected with waterfalls through crevasses in the great glacier. The allied feature of pot-holes, found just beyond the limits of the island, was then discussed, and another hypothesis advanced to account for their formation.

A sudden southward change in the direction of the glacial furrows over the island, their asymmetric form, and distinct southward curvature were described as evidences of a decided slope of the general surface toward the south-southwest, at the time of its subsidence during the glacial movement. A topographical modification was also referred to, through the undercutting of joint planes facing the northeast.

Dr. **Kunz** stated that during the spring of 1905 there had been shown to him some precious garnet, pyrope, in rounded irregular transparent grains, measuring from two to five millimeters in diameter. That these had been found in the tunnel extension of the New York subway, about 1200 feet south of Pier No. 1, North River, under New York Harbor, at a depth of 110 feet below the bed of the bay. That upon visiting the locality he found that the entire walls of the tunnel had been

covered with the iron arches, and it was impossible to see the rocks themselves, but that upon the dump heap he found a number of masses of serpentine weighing from two to one hundred pounds each. The serpentine was a rich yellow, a trifle darker than that found at Montville, N. J. Cleavages of feldspar nearly a foot long, black tourmaline, almandite, garnet in grains and in crystals were noted, but no peridotite itself was seen. This was probably due to the fact that nearly all the material taken from the tunnel was removed by barges to the deep ocean and dumped. Dr. Kunz stated that it was most unfortunate that what was undoubtedly the evidence of a peridotite dike upon New York island should have been lost. A mass of stilbite gneissoid wall, measuring six feet by ten and nearly covered by rich stilbite, was noted. Mr. C. Wotherspoon, the engineer in charge of the night work, was most courteous in giving information and in collecting specimens.

A. W. GRABAU,
Secretary.

SECTION OF BIOLOGY.

NOVEMBER 13, 1905.

Section met at 8.15 P.M., Vice-President Wheeler presiding.

The minutes of the last meeting of the Section were omitted on account of the absence of the Secretary.

The following program was then offered:

H. F. Osborn THE RECLASSIFICATION OF THE MAMMALIA.

Katherine Foote, THE PROPHASES OF THE FIRST MATURATION SPINDLE OF ALLOLOBOPHORA.

H. E. Crampton, BRIEF REPORT OF STATISTICS RELATING TO SEX-INHERITANCE IN MOTHS.

B. E. Dahlgren, DEMONSTRATION OF NEW INVERTEBRATE MODELS IN THE AMERICAN MUSEUM.

The nomination of officers for the ensuing year was then announced as the business part of the program. In the absence of the Secretary, R. W. Miner was appointed Secretary *pro tem.* Professor H. E. Crampton was nominated to the Council

as Vice-President and Chairman of the Section. M. A. Bigelow was re-elected Secretary of the Section. The meeting then adjourned.

Summary of Papers.

Professor **Osborn** said in his paper that it is surprising to find how little attention is given in modern works to the authorship of the larger taxonomic divisions of the Mammalia, and what mistaken ideas are current as to past leadership in classification.

In the present study of this subject historically Mr. W. K. Gregory has been devoting several weeks to reviewing and abstracting the literature, making a number of valuable suggestions, and Mr. T. S. Palmer of the Biological Survey of the U.S. Agricultural Department, has rendered invaluable aid and criticism from his stores of knowledge.

As an expression of our knowledge of the phylogeny or relationships and descent of the mammals, classification shifts and changes with research and discovery. Looking back we find that those authors, such as De Blainville, exerted the most permanent influence who had the keenest appreciation of genetic affinities, while others, like Gray, who have lacked all sense of such affinities, have made no impression. Finally, in schemes of classification we express clumsily in words our knowledge and more or less our theories also of the affinities, the divergences or continuous branchings and sub-branchings which have resulted in the great diversity of extinct and modern forms.

Discovery of these branchings from time to time necessitates an increase in the number of subdivisions. For example, in order to express the facts known at the present time it appears to be necessary:

(1) To introduce the new branch *infra-class;*

(2) To employ more frequently the branch *super-order;*

(3) To revive for descriptive purposes at least the branch *cohort* of Storr.

Thus in place of the three branches employed by Linnæus,

namely, class, order, genus, we require eleven kinds of branches, namely·

- Class
- Sub-class
- Infra-class
- Cohort
- Super-order
- Order
- Sub-order
- Super-family
- Family
- Sub-family
- Genus

Super-orders. The forty known orders of mammals shown in the following table, namely, twenty-one living and nineteen extinct, cannto as yet be united uniformly into super-orders, yet the tendency of discovery will be constantly in this direction. Thus Roth's union of the South American hoofed forms into Notungulata (i.e., Southern Ungulates) is a happy step forward; the Hyracoidea of Africa may possibly be added to this branch. Similarly the tendency of discovery (Andrews) is to revive De Blainville's idea and unite the Proboscidea and Sirenia into a new super-order, to which possibly the Pyrotheria of South America may some day be added. Our super-order column, however, requires much additional study and discovery.

Orders. Among the forms in our order column which are still most uncertain are the above-mentioned Pyrotheria, the Barypoda (an order proposed for the reception of *Asinoitherium* and related forms of Eocene Africa), the Mesodonta (primitive North American monkeys which will possibly be included with the South American forms), the Tubulidentata (South American aardvarks, latterly removed from the Edentata and showing some affinities in the brain to the Ungulata, Elliot), the Pholidota (Pangolins, also recently removed from the Edentata although the brain presents a feeble claim to this relationship—Elliot), the Proglires (an order of doubtful value and position), the Protodonta and Allotheria, also of doubtful relationship. A striking recent triumph of palæontology is the removal of the Zeuglodontia (ancient Eocene whale-like forms) to the vicinity of the Creodonta; it had long been suspected that the Cetacea should be nearer the Carnivora than other orders. Beddard suggests Edentate affinities.

Cohorts. The branches in the cohort column represent the modified revival of a very ancient usage. The groupings are, however, very general and uncertain, especially as regards the branch Ungulata, because we still need to ascertain whether the hoofed animals sprang from a common "Protungulata" stock, as has been supposed, or whether they were more or less independently derived from the Unguiculata—if the latter supposition is the correct one, the term Ungulata (Storr) becomes purely descriptive.

Infra-class. The chief object of the new Infra-class division is to express the fact that the Marsupials and Placentals, while widely separate, are also much more closely related to each other than either are to the Monotremes.

CLASS	SUB-CLASS	INFRA-CLASS	COHORT	SUPER-ORDER	ORDER	
Mammalia	I. Prototheria	I. Ornithodelphia.			Monotremata....	1
					[1]Protodonta......	2
					[1]Allotheria.......	3
	II. Eutheria	1. Didelphia or Marsupialia			Polyprotodonta..	4
					Diprotodontia ..	5
					[1]Triconodonta....	6
		2. Monodelphia or Placentalia	1. Unguiculata	Pristini	Pantotheria.....	7
					Insectivora......	8
					Dermoptera.....	9
					Cheiroptera.....	10
			"	Ferae (Carnivora)	[1]Creodonta.......	11
					[1]Zeuglodontia....	12
					Fissipedia.......	13
					Pinnipedia......	14
			"	Glires	[1]Proglires?.......	15
					Rodentia........	16
					Tillodontia......	17
			"	Edentata	[1]Tæniodonta......	18
					Xenarthra......	19
					Pholidota.......	20
			"		Tubulidentata...	21
			2. Primates?	Primates	[1]Mesodonta......	22
					Prosimii........	23
					Simiæ..........	24
			3. Ungulata	Diplarthra?	Perissodactyla ..	25
					[1]Ancylopoda.....	26
					Artiodactyla....	27
					[1]Condylarthra....	28
					[1]Amblypoda.....	29
					[1]Barypoda.......	30
					Proboscidea.....	31
					Sirenia.........	32
					Pyrotheria.......	33
					Hyraces.........	34
				Notungulata Roth	Typotheria......	35
					Toxodontia.....	36
					Astropatheroidea	37
					Litopterna......	38
			4. Cete		Denticete........	39
					Mysticete.......	40

[1]Extinct orders.

Miss Foote and **Mr. Strobell** showed lantern slides of fourteen photo-micrographs illustrating a few stages in the prophases

and metaphase of the first maturation spindle of the egg of *Allolobophora fœtida*.

These slides demonstrated the following phenomena:

1. In this form the chromosomes lose their individuality completely during the growth period, the chromatine being distributed throughout the germinal vesicle. It then segregates into a chromatic reticulum and later forms a spireme which divides transversely into eleven bivalent chromosomes. The spireme shows a longitudinal split, which persists until the metaphase and produces the typical tetrad.

2. The form of the chromosomes is not constant. The eleven bivalent chromosomes of the prophases and metaphase may be in the form of rings, crosses, figures eight, or rods, these forms being inconstant and variable.

3. The size relations are not constant. There is a marked difference in size, but it is not possible to accurately identify any one or more chromosomes on account of a definite individual or relative size.

4. The number of oöcyte chromosomes is a *constant* feature. Eleven bivalent chromosomes can be accurately and constantly demonstrated.

No other abstracts have been received.

Roy W. Miner,
Secretary pro tem.

SECTION OF ASTRONOMY, PHYSICS AND CHEMISTRY.

November 20, 1905.

Section met at 8.15 P.M., at the American Museum of Natural History, Mr. C. C. Trowbridge presiding.

The minutes of the last meeting were read and approved.

The following program was then offered:

Charles C. Trowbridge, Meteor Trains.

After the reading of the paper there was an informal discussion, followed by the presentation of the following business:

The question of holding bi-monthly instead of monthly meetings was discussed, and it was voted that the matter be referred to the Council with recommendation that the change be made.

It was voted that steps be taken by the Secretary to arrange for holding one or more meetings during the year in conjunction with the Physics Club of New York City.

A letter from Vice-President von Nardroff was read regretting his inability to attend the meetings of the Section during the coming year.

C. C. Trowbridge was elected Chairman of the Section for the ensuing year.

It was voted to postpone the election of the Secretary until a later meeting.

The Section then adjourned.

ROY W. MINER,
Secretary pro tem.

SECTION OF ANTHROPOLOGY AND PSYCHOLOGY.

NOVEMBER 27, 1905.

Section met at 4.15 P. M., at Columbia University, and 8.30 P.M., at the American Museum of Natural History, Vice-President Woodbridge presiding.

The minutes of the last meeting of the Section were read and approved.

The following program was then offered:

Afternoon Session:

W. S. Monroe, SMELL DISCRIMINATION OF STUDENTS.
F. Lyman Wells, LINGUISTIC STANDARDS.
F. M. Hamilton, A STUDY OF THE READING PAUSE.
R. S. Woodworth, VISION AND LOCALIZATION DURING RAPID EYE MOVEMENTS.

Evening Session:

J. McKeen Cattell, MEASUREMENT OF SCIENTIFIC MERIT.
Brother Chrysostom, TEMPERAMENT AS AFFECTING PHILOSOPHIC THOUGHT.
W. P. Montague, ARE MENTAL PROCESSES IN SPACE?
C. M. Bakewell, CONCERNING EMPIRICISM.

Election of sectional officers for 1906:

Chairman, Robert MacDougall.

Secretary, R. S. Woodworth.

Adjourned at 10 P.M.

Summary of Papers.

Professor **Monroe** described an experiment in which students were provided with sets of small vials filled one third full of common odors—chiefly essential oils. Each set contained twenty odors. Nostrils were alternately used; five seconds were given for the stimulation, and one minute was allowed for recording the result and resting the nostrils. After every seven tests, the windows were opened and the room aired. In all, 255 students were tested. The average number of odors correctly named was 6.72. Four students named twelve correctly; two students, eleven; and five students, ten. Two of the students were able to identify but one odor each; fifteen students, but two odors each; and seventeen students, but three odors each.

Wintergreen was correctly identified by 77 per cent. of the students; camphor, 75 per cent.; peppermint, 75 per cent.; vanilla, 74 per cent.; cloves, 65 per cent.; cinnamon, 56 per cent.; spearmint, 38 per cent.; turpentine, 36 per cent.; tar, 36 per cent.; lemon, 30 per cent.; nutmeg, 27 per cent.; anise, 26 per cent.; pennyroyal, 21 per cent.; sassafras, 15 per cent.; bay rum, 9 per cent.; hemlock, 4 per cent.; bergamot, 3 per cent.; assafœtida, 2 per cent.; wormwood, 1 per cent.; and lavender, half of one per cent. A census of odor names showed that the students believed themselves familiar with certain odors, such as lavender, which they were unable to recognize.

Dr. **Wells's** paper stated that a historical standard is necessary for the regulation of linguistic usage, but the present literary interpretation of it is open to many objections, being reactionary in character and inconsistent in its admissions and exclusions. Models of linguistic excellence, as determinative of that body of elements to be considered good use, are to be sought among works whose criteria of value are more objective in character than is the case at present, as their value can be more rapidly and more accurately determined, and they are in closer touch with the actual needs of the language. The introspection of the author of the average "Principles of Rhetoric" should not be accepted as final in determining

the interrelationship of these elements of good use. It is possible to determine linguistic values of all sorts by statistical methods, which give not only the most valid determination possible, but also the measure of this validity. Determinations of so apparently subjective a character as linguistic force can be made with a validity that approximates practical certainty. These experimental determinations do not coincide with any of the definitions of force which the introspective grammarians have laid down.

Dr. **Hamilton** reported that previous investigators of the problem of reading have agreed upon the short exposure method as best for psychological analysis. Introspection is facilitated most when the exposure is less than the shortest reading pause, *i. e.*, when all eye movements are excluded. The apparatus most generally used is the tachistoscope of the fall screen variety. The word has been uniformly treated as the unit of perception in reading, the effort being to determine the factors or "cues" of word recognition—their character and order of occurrence.

Previous tachistoscopic studies have confined themselves chiefly to the reading of isolated words; the present study has attempted to adapt the method to reading in context.

A second adaptation is its use in analyzing processes at the threshold of word recognition by reducing the exposure time to a period approximating the time differences of the perceptibility of their attributes, the presupposition being that various attributes of objects lie at varying distances from the threshold.

And still a third untried possibility of this method consists in reports upon the marginal field of perceptual regard in addition to the reports upon the field of distinct vision.

The experiments have already proceeded far enough to give assurance that the completion of the study will shed additional light upon the questions of literal reading, reading cues, value of context, etc.

An attempt was made by Professor **Woodworth** to throw some additional light on the question, first raised by Cattell,[1] as to what is seen during movements or jumps of the eye from

[1] *Psychological Review*, 1900, VII., pp. 325–343, 507–508.

one fixation point to another. Two opposing views are those of Holt,[1] who holds to a complete anæsthesia or inhibition of the visual centre during the movement, and of Dodge,[2] who believes that vision there is possible but under ordinary conditions not actualized, because the faint blur produced by moving the eye across a variegated field is so brief and meaningless as to be ignored, just as entoptic phenomena are ignored. Proceeding on the supposition that if the latter view were correct it should be possible by attention and practice to become conscious of the stimuli that affect the eye during movement the author has convinced himself of the following facts:

1. During head movements, an object held in the mouth may remain in clear vision.

2. During convergence, the two monocular fields may be seen to move across each other.

3. During eye-jumps proper, after-images may remain in consciousness if the lids are closed (Exner), or if the background is dark or plain; it is also possible, in short jumps, or at the beginning and end of longer ones, to see entoptic spots move across the background.

4. External objects moving in the same direction as the eye are distinctly seen when their angular velocity with respect to the eye coincides with that of the eye at any part of its jump (Cattell, Dodge). With reference to Holt's objection that what is seen may be the positive after-image, appearing after the eye has come to rest, it should be noted that the objects so brought to clear vision are correctly localized in space, instead of being projected against the background at the new point of fixation, as would be the case with after-images. Thus not only vision, but correct localization of objects seen, is possible during eye-jumps.

5. Stationary objects over which the eye passes can also be seen after practice. Fusion, flicker, and especially apparent motion of the objects, corresponding to the actual motion of

[1] *Psychological Review, Monograph Supplements*, 1903, IV., pp. 3–45; *Psychological Bulletin*, 1905, II.

[2] *Ibid.*, 1900, VII., pp. 454–465; *Psychological Bulletin* 1905, II., pp. 193–199.

their images across the retina, can all be seen. A peculiarity which calls for further discussion is that the apparent extent of the object's motion is much less than the actual motion of the eye as measured against the background.

The author's conclusion is that vision with the moving eye is essentially the same as that with the fixed eye when the external field moves.

Professor **Cattell** explained how he had selected a group of one thousand scientific men for the study of individual differences and the conditions on which success in scientific work depends. In each of the twelve principal sciences the students who had done original work were arranged in the order of merit of their work by ten competent judges. Thus was obtained the order of merit and also the proper error of each position, it being based on ten independent observations. This probable error is inversely as the differences in scientific method, it being small where the differences are marked and becoming larger as the differences are less. It is thus possible to construct a curve representing the distribution of scientific merit in these thousand scientific men, and this curve agrees rather closely with the positive half of the curve of error. The first hundred men differ among themselves about as much as the next two hundred or the last seven hundred.

Data were also given in regard to the distribution of the thousand leading scientific men of the country. The birth-rate of these scientific men was 27 per million of the population, it being 50 in cities and 24 in the country. It was 109 in Massachusetts, 47 in New York, 23 in Pennsylvania, 12 in Missouri, and 1 in Mississippi and in Louisiana. Their present distribution is somewhat similar. Thus 134 scientific men were born in Massachusetts and 144 reside there; 183 were born in New York and 192 reside there. The central States, with the exception of Illinois, tend to lose their scientific men. Thus 75 were born in Ohio, and 34 now reside there. The distribution of these scientific men among different institutions is as follows: Harvard, 66; Columbia, 60; Chicago, 39; Cornell, 33; U. S. Geological Survey, 32; U. S. Department of Agriculture, 32; Johns Hopkins, 30; California, 27; Yale, 26; Smith-

sonian Institution, 22; Michigan, 20; Massachusetts Institute of Technology, 19; Wisconsin, 18; Pennsylvania, 17; Stanford, 16; Princeton, 14; Minnesota and Ohio State, 10 each.

In his paper, **Brother Chrysostom** stated that it is impossible either to understand the great philosophers or to appreciate their influence if we limit ourselves to a purely scientific standpoint. Temperament enters so largely as a factor, both in determining the principles on which they lay special stress and in gaining disciples for their respective schools, that we are forced to consider them also from a literary view-point if we would do them justice. The ingredients that form temperament may be arranged under the following heads: (1) Heredity, which is especially helpful in tracing tendencies favoring the pursuit of the concrete; (2) environment, which is closely interwoven with heredity and may be called a condition of its development as a factor in mental life; (3) race and nationality—no Frenchman will treat a subject in the same manner as a German; (4) the attraction exercised by the first philosopher who interests a thinker; (5) the time or epoch in which the philosopher lived, for history is governed to a great extent by the law of reaction and adjustment, which results in the formation of cycles of thought; (6) the personality of the founder. This leads him to lay emphasis upon certain phases of truth to the neglect of others. To estimate his influence we must attend to the elements of truth contained in his system of thought.

Dr. **Montague** protested first against the current paradoxical view of mental processes as real occurrences that occur nowhere. They should be located in space for the following reasons: (1) They are naturally felt to be within the body; (2) they form no exception to the generally accepted rule that an invisible event, such as an electric current, is to be located in the visible object that directly conditions it; (3) their phenomenal existence in space (like their existence in time) is not in conflict with the transcendental view that space and time are appearances; (4) that they are neither punctiform nor figured is no argument against their location in space, for many things—notably, sounds and odors—are definitely located in space

without being regarded as either punctiform or figured; (5) the objection that there is no room in space for anything but matter and motion, and that thoughts and feelings if they were really in the brain would have to be regarded as visible substances between or alongside of the brain molecules, is invalid; for it disregards the fact that sensations are intensive and not extensive, and that they must, therefore, occupy space in the same way as other intensities, such as stresses, velocities, and accelerations, which exist in space *along with* their matter and not *alongside* of it.

The last part of the paper explained and defended the hypothesis that mental states are the modes of potential energy (expressible in terms of the higher derivatives of space with regard to time) into which the kinetic energy of the nerve currents must be transformed in order to be redirected. The theory, if true, would justify the belief in interaction without violating the parellelists' contention that the spatial can only be causally related to what is in space.

R. S. Woodworth,
Secretary.

BUSINESS MEETING.

December 4, 1905.

The Academy met at 8.15 P.M., at the American Museum of Natural History, President Kemp presiding.

The minutes of the last meeting were read and approved.

The Secretary reported from the Council as follows:

At the meeting of the Council held Nov. 27, at 4 P.M., the following officers were nominated for the year 1906, according to the By-Laws:

President, N. L. Britton.

Vice-Presidents, Edmund Otis Hovey, H. E. Crampton, C. C. Trowbridge, Robert MacDougall.

Corresponding Secretary, Richard E. Dodge.

Recording Secretary, William M. Wheeler.

Treasurer, Emerson McMillin.

Librarian, Ralph W. Tower.

Editor, Charles Lane Poor.

Councilors, John H. Finley, Hermon C. Bumpus.

Finance Committee, John H. Hinton, C. A. Post, Henry F. Osborn.

It was voted that the Annual Meeting should consist of a formal meeting for the presentation of the reports of officers and the election of officers for the ensuing year, to be followed by a subscription dinner, at which the address of the President would be delivered. Due notice will be given members of the time and place of this meeting.

It was voted that the report of the Council be approved.

The death of John H. Hinton was then announced by D. S. Martin.

It was voted that a committee be appointed by the Chairman to draw up resolutions, with regard to the matter.

The President appointed Professor Martin and Professor Stevenson to serve on this committee.

Mr. George F. Kunz then announced the death of Dr. Augustus Choate Hamlin, geologist, of Bangor, Me., and moved that a committee be appointed to draw up appropriate resolutions. It was so voted.

The President appointed Dr. Kunz as a committee of one to draw up the resolutions.

The following candidates were then presented for election to Active and Associate Active membership, having been recommended by the Council:

M. Baxter, Jr.	32 West 60th Street
Martin Beckhard	102 West 87th Street
T. W. Blake	1945 Park Avenue.
Frank Briesen	87 Nassau Street
André Champollion	150 West 47th Street
William L. Condit	624 Bloomfield Street, Hoboken, N.J.
Warren Delano, Jr.	1 Broadway
Louis J. de Milhau	48 Mt. Auburn Street, Cambridge, Mass.

James A. Garland	Box 500, Bristol, R.I.
L. V. Holzmaister	150 West 72d Street
John E. MacDonald	216 West 72d Street
Alfred E. Marling	47 West 47th Street
George B. Morewood	156 West 76th Street
R. J. Nunn	5 York Street, E., Savannah, Ga.
P. J. Oettinger	416 Central Park West
Henry Phipps	6 East 87th Street
Carl Pickhardt	1042 Madison Avenue
William Procter	11 East 52d Street
F. James Reilly	13 West 77th Street
James H. Rogers	60 Wall Street
Charles M. Schott, Jr.	25 Broad Street
W. Wheeler Smith	17 East 77th Street
Samuel B. Snook	182 Hart Street, Brooklyn
Isidor Straus	2745 Broadway
J. E. Hulshizer	16 Gifford Avenue, Jersey City
Henry E. Taylor	306 West 80th Street
Jeremiah R. van Brunt	1841 84th Street, Brooklyn
Robert A. van Wyck	149 Broadway
Wendell T. Bush	167 Joralemon Street, Brooklyn, N.Y.
Lincoln Cromwell	3 East 84th Street, N.Y. City
J. M. Conn	544 West 114th Street
John S. Durand	126 West 79th Street
Walter Irving	121 East 37th Street
Adrian S. Lambert	29 West 36th Street
J. M. O'Brien	252 West 72d Street
Juliette A. Owen	306 North Ninth Street, St. Louis, Mo.
William H. Vredenburgh	868 West End Avenue, N.Y. City.

Associate Active Member

G. W. Hunter	2238 Andrews Avenue, University Heights

The candidates were unanimously elected by vote of the Academy.

The meeting then adjourned.

HERMON C. BUMPUS,
Recording Secretary.

SECTION OF GEOLOGY AND MINERALOGY.

DECEMBER 4, 1905.

Section met at 8.30 P.M., Vice-President Hovey presiding.

The minutes of the last meeting of the Section were read and approved.

The following program was then offered:

J. Howard Wilson,	THE GLACIAL GEOLOGY OF NANTUCKET AND CAPE COD.
Thomas T. Read,	GOLD MINING IN THE SOUTHERN APPALACHIANS.
George F. Kunz,	DESCRIPTION OF THE MODOC, SCOTT COUNTY, KANSAS, METEORITE.

SUMMARY OF PAPERS.

Dr. **Wilson** commenced his paper with a description of the region by means of a map showing the great morainal features of the late Wisconsin ice-sheet. It was shown that the glacial phenomena and accumulations were due to two very distinct lobes having a direction of motion approximately at right angles to each other. The eastern lobe was termed the Nantucket lobe and the other the Long Island lobe from the more prominent region of its moraines.

It was shown also that each lobe had two prominent associated stages, one the time of maximum advance, and the other a period of halting in the final retreat.

The glacial features of Nantucket and as far west as the central portion of Martha's Vineyard were formed during the first or Nantucket stage of that lobe, while the morainal accumulations of the western portion of Martha's Vineyard, Block Island, and the outer moraine of Long Island were formed

during the corresponding stage of the Long Island lobe or in what was termed the Martha's Vineyard-Block Island stage.

The retreat of the Nantucket lobe to Cape Cod, where it halted for a time, formed the Cape Cod stage of this lobe, while a retreat of the front of the western lobe to a poison on the Elizabeth Island, Southern Rhode Island, Fisher's and Plum Islands, and the northern part of Long Island resulted in what was termed the Elizabeth Island-Fisher's Island stage. It is well known that the ice of the Long Island lobe had a general southeasterly motion, but it was shown that the Nantucket lobe came from the northeast, probably from a region as distant as Newfoundland, and no doubt extended seaward at least 150 miles. Between the two lobes was formed the interlobate moraine extending from Wood's Holl on Cape Cod to and beyond Manomet Hill in the neighborhood of Plymouth.

It was shown that the Nantucket lobe had what might be called a third stage, when it began to melt back from the Cape Cod moraine in the vicinity of West Barnstable, its front still holding on to the east and west. Fresh water was thus held up by the morainal ridge in a re-entrant angle of the retreating ice, bringing into existence Cape Cod Lake. It was during the existence of this lake that the sand plains of Eastern Wellfleet Highlands, and Truro were formed.

It was further shown that Cape Cod Lake had three distinct stages, the Wellfleet. Highlands, and Truro stages, marked by three different levels of its waters and the formation of a particular series of plains.

Numerous maps and views of the prominent glacial features throughout the region were shown.

Mr. **Read** first pointed out that the Southern Appalachian region was one of the earliest to which the search for gold was directed after the discovery of the New World.

After tracing the early development up to the present, the geological structure of the region and the methods of occurrence of the ore were described. The paper then touched on the present state of the industry and the methods of working, and concluded with a forecast of the probable future worth of the deposits.

Dr. **Kunz** described the Modoc, Scott County, Kansas, meteorite, that detonated over Modoc at 9.30 P.M., Sept. 2, 1905. First a loud sharp report was heard; then followed a rumbling for thirty seconds, when a shower of over a dozen stones fell which weighed from one ounce to twelve pounds each. The stone is an almost white, pulverulent mass, with minute specks of native iron or troilite, with an occasional white, glassy, cleavable feldspar inclusion.

A. W. GRABAU,
Secretary.

SECTION OF BIOLOGY.

DECEMBER 11, 1905.

Section met at 8.15 P.M., at the American Museum of Natural History, Vice-President Wheeler presiding.

The minutes of the last meeting of the Section were read and approved.

The following program was then offered:

Adele M. Fielde, THE PROGRESSIVE ODOR OF ANTS AND ITS INFLUENCE IN THEIR COMMUNAL LIFE.

A. F. Bandelier, ANIMAL LIFE IN PERU AND BOLIVIA.

May Cline, PRINCIPLES OF BIRD FLIGHT.

F. M. Chapman, CERTAIN INSTINCTS IN BIRDS.

No abstracts received.

M. A. BIGELOW,
Secretary.

ANNUAL MEETING.

DECEMBER 18, 1905.

The Academy met for the Annual Meeting on Monday, Dec. 18, 1905, at 7.30 P.M., at the Hotel Endicott; President Kemp in the chair. A formal session for the transaction of regular business was held, followed by a dinner, at which sixty-one were present, including forty-six members and their friends.

The accompanying reports of the Corresponding Secretary, Recording Secretary, Librarian, and Editor were read and placed on file. The Treasurer not being able to present his report, on account of absence from town, it was voted that it be referred to the Finance Committee for audit, when presented.

The following members were elected Fellows by the Academy:

Professor Charles Baskerville	Dr. Maurice Fishberg
Mr. C. William Beebe	Mr. Gifford Pinchot
Dr. John H. Finley	Mr. George H. Sherwood

The Academy then proceeded to elect officers for the year 1906. Professors Crampton and Trowbridge were appointed tellers, ballots prepared by the Council according to the By-Laws were distributed, and the votes were counted. The following officers were declared elected:

President, Nathaniel L. Britton.

Vice-Presidents, E. O. Hovey (Section of Geology and Mineralogy), H. E. Crampton (Section of Biology), C. C. Trowbridge (Section of Astronomy, Physics, and Chemistry), Robert MacDougall (Section of Anthropology and Psychology).

Corresponding Secretary, Richard E. Dodge.

Recording Secretary, William M. Wheeler.

Treasurer, Emerson McMillin.

Librarian, Ralph W. Tower.

Editor, Charles Lane Poor.

Councilors (to serve three years), Hermon C. Bumpus, John H. Finley.

Finance Committee, John H. Caswell, C. A. Post, Henry F. Osborn.

The President of the Academy, Professor James F. Kemp, then delivered his address upon "The Problem of the Metalliferous Veins," after which a vote of thanks was tendered to him.

The Academy then adjourned.

HERMON C. BUMPUS,
Recording Secretary.

REPORT OF THE CORRESPONDING SECRETARY.

During the year, the Assistant Secretary, Mr. Miner, has sent the customary biennial circulars to the Honorary and Corresponding members and has already received replies from more than three fourths of his inquiries.

According to our corrected lists, there are now fifty Honorary Members and one hundred and seventy-one Corresponding Members.

During the last year two Corresponding Members, Professor Alpheus S. Packard and Professor Albert A. Wright, have died.

RICHARD E. DODGE,
Corresponding Secretary.

REPORT OF THE RECORDING SECRETARY.

During the year 1905 the Academy held eight business meetings, and twenty-eight sectional meetings, at which eighty-four stated papers and lectures were presented, on the following subjects:

Astronomy	3 papers.	Physiography	1 paper, 1 lecture.
Physics	6 "		
Chemistry	3 "	Anthropology and Archæology	6 papers, 1 lecture.
Paleontology	5 "		
Biology	14 "		
Geology	11 "	Psychology	24 papers.
Mineralogy	3 "	Philosophy	5 "
		Physiology	1 "

At the present time the membership of the Academy includes 424 Active Members, nineteen of whom are Associate Active Members, and 121 Fellows. The election of six Fellows is pending. There have been five deaths during the year, seven resignations, and one member has been dropped for non-payment of dues. The new members elected during the year number 159. A year ago only five new members were elected. During the past year there has been a net gain of 146 against a loss of nine in 1904. This remarkable showing, which amounts to an increase of 50 per cent., is due to the activity of the Mem-

bership Committee, of which Professor Stevenson is chairman, and is the result of the determination of the Council to devote especial attention to the matter of membership, as stated in the Recording Secretary's Report of a year ago. While striving to increase the membership the Academy has had in view the securing of men interested in science, even though not active scientific contributors, and by the establishment of a new grade of membership, viz. that of Associate Active Membership, many young men have been brought in.

Efforts have also been made to invite to the sectional meetings persons who are not members of the Academy but who are interested in the various branches of science to which these sections are devoted.

The routine work of the Academy has now been concentrated in one office at the American Museum of Natural History, where an Academy Room has been provided so as to be adapted to our special needs.

It is with sorrow that the Academy has to record the loss by death of the five following members:

Dr. John H. Hinton, Fellow and Patron of the Academy (40 years).

Dr. L. H. Laudy, Fellow (24 years).

The Hon. Edward Cooper (38 years).

Mr. John Murray Mitchell (19 years).

Mr. Wheeler H. Peckham (7 years).

Respectfully submitted,

HERMON C. BUMPUS,
Recording Secretary.

REPORT OF THE TREASURER.

New York, Dec. 18, 1905.

To the New York Academy of Sciences.

Gentlemen:—As required by the By-Laws, I herewith submit a statement of my receipts and disbursements since my last annual report, and a balance sheet from my ledger, as of this date.

Respectfully yours,

C. F. Cox,
Treasurer.

Receipts.

Balance on hand, as per annual report Dec. 20, 1904		$2,266.24
One year's interest at $4\frac{1}{2}\%$ on Lampe Mortgage (St. Ann's Ave.) for $12,000		540.00
One year's interest at 5% on Brennan Mortgage (East 135th St.) for $5,200		260.00
Life Membership Fees		1,200.00
Initiation Fee		5.00
Active Membership Dues, 1902	$20.00	
" " " 1903	60.00	
" " " 1904	150.00	
" " " 1905	2,615.00	
" " " 1906	40.00	
		2,885.00
Associate Membership Dues, 1905		45.00
Interest on Deposit in Bank		61.72
Surplus from Annual Dinner, 1904		4.00
Sales of Reprints, etc		104 09
		$7,371.05

Disbursements.

Publications	$1,892.45	
Expenses Recording Secretary and Assistant Secretary	370.58	
Typewriter	90.00	
Salary Asst. Secretary, 11 months	733.26	
Expenses of Treasurer	25.00	
" " Librarian	95.95	
" " Corresponding Secretary	2.10	
General Expenses, including expenses of Special Committee on Membership	185.30	
Expenses, Geological Section	11.35	
" Section of Astronomy and Physics	5.45	$3,411.44
Balance on hand		$3,959.61

BALANCE SHEET.

DR.

Investments	$17,200.00
Cash on Hand	3,959.61
	$21,159.61

CR.

Permanent Fund	$12,431.68
Publication Fund	3,000.00
Audubon Fund	1,897.25
Income of Audubon Fund	250.99
Income of Publication Fund	323.77
Income of Permanent Fund	1,586.31
General Income	1,665.61
Annual Dinners	4.00
	$21,159.61

REPORT OF THE LIBRARIAN.

The Library has received during the past year, by gift and exchange, 299 Volumes, 233 Pamphlets and 1613 Numbers, which have been duly acknowledged, accessioned, and placed on the shelves for reference.

The Library is open to the public on each week-day from 9.30 A.M. to 5 P.M. The books have been frequently consulted and it is desired that their use shall be continued.

R. W. TOWER,
Librarian.

REPORT OF THE EDITOR.

New York, Dec. 18, 1905.

During the year 1905 the Academy printed and issued the following publications:

ANNALS.—Vol. XVI, Part 1, containing four papers as follows: Louis I. Dublin, "History of Germ Cells in *Pedicellina americana* Leidy;" D. S. Martin, "H. Carrington Bolton;" J. J. Stevenson, "The Jurassic Coals of Spitzbergen;" J. Howard Wilson, "Recent Journeys among Localities Famous for Prehistoric Man." This part was issued in March and consisted of ninety-seven pages, three plates and two text figures.

Vol. XVI, Part 2, which contained papers by Waldemar

Jochelson, entitled, "Grammar of the Yukaghir Language;" by Maurice Fishberg, "Materials for the Physical Anthropology of the Eastern European Jews;" and the records of the meetings of the Academy for the year 1904. This part was issued in August and contained 290 pages, one plate, and thirteen text figures.

Total number of pages of the Annals issued during the year was thus 387.

MEMOIRS.—Vol. II, Part 4, consisting of an elaborate research paper by W. E. Kellicott entitled, "The Development of the Vascular and Respiratory Systems of *Ceratodus*." This consisted of 114 pages, five plates, two of which were printed in colors, and 106 text figures. A portion of the expense of printing this Memoir was borne by the Audubon Fund.

ANNALS.—Vol. XVI, Part 3, is now in press and should be issued soon after the beginning of the year.

CHARLES LANE POOR,
Editor.

THE ANNUAL ADDRESS OF THE PRESIDENT.

THE PROBLEM OF THE METALLIFEROUS VEINS.

By James Furman Kemp.

The rush of the gold-seekers to California in 1849 and the quickly following one to Australia in 1851 were notable migrations in search of the yellow metal, but they were not the first in the history of our race. There is, indeed, no reason to suppose that, in the past, mining excitements were limited even to the historical period; on the contrary the legends of the golden fleece and of the golden apples of the Hesperides probably describe in poetic garb two of the early expeditions, and long before either, we can well imagine primitive man hurrying to new diggings in order to enlarge his scanty stock of metals. Among the influences which have led to the exploration and settlement of new lands, the desire to find and acquire gold and silver has been one of the most important, and as a means of introducing thousands of vigorous settlers, of their own volition, into uninhabited or uncivilized regions there is no agent which

compares with it. In this connection it may be also remarked that there is no more interesting chapter in the history of civilization than that which concerns itself with the use of the metals and with the development of methods for their extraction from their ores. Primitive man was naturally limited to those which he found in the native state. They are but few, viz., gold in wide but sparse distribution in gravels; copper in occasional masses along the outcrops of veins, in which far the greater part of the metal is combined with oxygen or sulphur; copper again, in porous rocks, as in the altogether exceptional case of the Lake Superior mines; iron in an occasional meteorite; which, if its fall had been observed, was considered to be the image of a god, descended from the skies;[1] silver in occasional nuggets with the more common ones of gold; and possibly a rare bit of platinum. Besides these no other metal can have been known, because all the rest and all of those mentioned, when locked up in their ores, give in the physical properties of the latter but the slightest suggestion of their presence. Chance discoveries must have first revealed the possibilities of producing iron from its ore—really a very simple process when small quantities are involved; of making bronze from the ores of copper and tin; of making brass with the ores of copper and zinc; of reducing copper and lead from their natural compounds; and of freeing silver from its chief associate, lead. All of these processes were extensively practised under the Chinese, Phenicians, Greeks, Romans and other ancient peoples.

As the need of weapons in war, the advantages of metallic currency, and the want of household utensils became felt, and as the minerals which yield the metals became recognized as such, the art of mining grew to be something more than the digging and washing of gravels; and in the long course of time developed into its present stage as one of the most difficult branches of engineering. Chemistry raised metallurgical processes from the art of obtaining *some of a metal* from its ore, to the art of obtaining *almost all* of it and of accounting for what escaped. It is, in fact, in this scientific accounting for every-

[1] As in the case of Diana of the Ephesians and the deity of the Carthaginians.

thing that modern processes chiefly differ from those of the ancients.

Of all the metals the most important which minister to the needs of daily life are the following, ranged as nearly as possible in the order of their usefulness: Iron, copper, lead, zinc, silver, gold, tin, aluminum, nickel, platinum, manganese, chromium, quicksilver, antimony, arsenic, and cobalt. The others are of very minor importance, although often indispensable for certain restricted uses.

The manner of occurrence of these metals in the earth, and their amount in ores which admit of practicable working, are fundamental facts in all our industrial development, and some accurate knowledge of them ought to be a part of the intellectual equipment of every well-educated man. The matter may well appeal to Americans, since the United States have developed within a few years into the foremost producer of iron, copper lead, coal, and until recent years in gold and silver; but with regard to gold, they have of late alternated in the leadership with the Transvaal and Australia, and in silver are now second to Mexico.

Despite the enormous product of food-stuffs, American mining developments are of the same order of magnitude; and the mineral resources of the country have proved to be one of the richest possessions of its people.

We may best gain a proper conception of the problem of the metalliferous veins if we state at the outset the gross composition of the outer portion of the globe, so far as geologists have been able to express it by grouping analyses of rocks. We may then note among the elements mentioned such of the metals as have just been cited and may remark the rarity of the others; we may next set forth the necessary percentages of each metal which make a deposit an ore, that is, make it rich enough for profitable working. By comparison we can grasp in a general way the amount of concentration which must be accomplished by the geological agents in order to collect from a naturally lean distribution in rocks enough of a given metal to produce a deposit of ore; and can then naturally pass to a brief discussion and description of those agents and their operations.

If the general composition of the crust of the earth is calculated as closely as possible on the basis of known chemical analyses, the following table results, which has been compiled by Dr. F. W. Clarke, of Washington, chief chemist of the U. S. Geological Survey.[1]

Oxygen	47.13
Silicon	27.89
Aluminum	8.13
Iron	4.71
Calcium	3.53
Magnesium	2.64
Potassium	2.35
Sodium	2.68
Titanium	.32
Hydrogen	.17
Carbon	.13
Phosphorus	.09
Manganese	.07
Sulphur	.06
Barium	.04
Chromium	.01
Nickel	.01
Strontium	.01
Lithium	.01
Chlorine	.01
Fluorine	.01
Total	100.00

Elements less than .01 per cent. are not considered abundant enough to affect the total, and equally exact data regarding them are not accessible. Among those given only the following appear which are metals of importance as such in everyday life: aluminum 8.13, iron 4.71, manganese .07, chromium .01, and nickel .01. They rank respectively, in the table, third, fourth, thirteenth, sixteenth and seventeenth. Of the five, iron is the only one of marked prominence. No one of the remaining four is comparable in usefulness with at least five other metals which are not mentioned, viz., copper, lead, zinc, silver, and gold.

An endeavor has been made by at least one investigator, Professor J. H. L. Vogt, of Christiania, to establish some quantitative expression for these other metals. His estimates are as follows:[2]

[1] Bulletin 148, p. 13.

[2] *Zeitschrift für prak. Geologie*, 1898, 324.

Copper, percentage beyond the fourth or fifth place of decimals, that is in the hundred thousandths or millionths of one per cent.

Lead and zinc, percentages in the fifth place of decimals, or in the hundred thousandths of one per cent.

Silver, percentage two decimal places beyond copper—or in the ten millionths to the hundred millionths of one per cent., or the ten thousandth to the hundred thousandth of an ounce to the ton.

Gold, percentage one tenth as much as silver.

Tin, percentage in the fourth or fifth decimal place, that is, in the ten thousandths or hundred thousandths of one per cent.

These figures, inconceivably small as they are, convey some idea of the rarity of these metals as constituents on the average of the outer six or eight miles of the earth's crust. But they are locally more abundant in particular masses of eruptive rocks which are associated with ore deposits.

In the following tabulation I have endeavored to bring together a number of determinations which have been made in connection with investigations of American mining districts. In a general way they give a fair idea of the metallic contents of certain eruptive rocks from which were taken samples as little as possible open to the suspicion that they had been enriched by the same processes which had produced the neighboring ore-bodies.

Copper,	.009	Missouri.[1]
Lead,	.0011	Colorado.[2]
Lead,	.008	Eureka, Nev.[3]
Lead,	.004	Missouri.[1]
Zinc,	.0048	Leadville, Colo.[4]
Zinc,	.009	Missouri.[1]
Silver,	.00007	Leadville, Colo.[5]
Silver,	.00016	Eureka, Nev.[3]
Silver,	.00016	Rosita, Colo.[6]
Gold,	.00002	Eureka, Nev.[3]
Gold,	.00004	Owyhee County, Id.[7]

[1] Average of eight eruptives from Missouri, Anal. by J. D. Robertson. Report on Lead and Zinc, Mo. Geol. Surv., II., 479.

[2] Average of six different rocks, embracing eighteen assays; S. F. Emmons, Monograph XII., U. S. Geol. Surv., 591.

[3] One rock, a quartz porphyry, not certain the rock was not enriched. J. D. Curtis, U. S. Geol. Surv., Mono. VII., 136.

[4] Same reference as under 6. The zinc was determined in but two samples.

[5] Same reference as under 6, but p. 594.

[6] S. F. Emmons, XVII. Ann. Rep. U. S. Geol. Survey, Part II., p. 471.

[7] A. Simundi in Tenth Census, XIII., 54.

In order to come within the possible limits of profitable and successful treatment the ores of the more important metals should have at least the following percentages, but that we may grasp the relations correctly, it must be appreciated that local conditions affect the limits. Thus in a remote situation and with high charges for transportation an ore may be outside profitable treatment although it may contain several times the percentages of those more favorably situated. Iron ores in particular which are distant from centres of population are valueless unless cheap transportation on a very large scale can be developed, while gold in an almost inacessible region, like the Klondike, may yield a rich reward, even when in quantities which, if expressed in percentages, are almost inappreciable.

The nature of the ore is also a factor of prime importance. Some compounds yield the metals readily and cheaply, while others, which in the case of the precious metals are often called base ores, require complicated and it may be expensive metallurgical treatment. The association of metals is likewise of the highest importance. Copper or lead, for example, greatly facilitate the extraction of gold and silver, whereas zinc in large quantities is a hindrance. Conditions also change. An ore which may have been valueless in early days may prove a rich source of profit in later years and under improved conditions. For instance, from 1870 for over twenty-five years Bingham Canyon in Utah yielded lead-silver ores and minor deposits of gold. It was known that in some mines low-grade and base ores of copper and gold existed, but the fact was carefully concealed and in at least one instance the shaft into them was filled up, lest a general knowledge of the fact should unfavorably affect the value of the property. To-day, however, these ores are eagerly sought and their extraction and treatment in thousands of tons daily are paying good returns on very large capitalization. Another factor is the expense of extraction. If simple and inexpensive methods are possible, the area of profitable treatment is greatly widened. Thus gold may need little else than a stream of water or even a blast of air, whereas iron and copper require huge furnaces and vast supplies of coke and fluxes.

Iron ores are of little value in any part of the world unless they contain a minimum of 35 per cent. iron when they enter the furnace, but if they are distributed in amounts of from 10 to 20 per cent., in extensive masses of loose or easily crushed rock in such condition that they can be cheaply concentrated up to rich percentages, they may be profitably treated and a product with 50 per cent. iron or higher be sent to the furnaces. Nevertheless, speaking for the civilized world at large, it holds true that as an iron ore enters the furnace it cannot have less than 35 per cent., and in America with our rich and pure deposits on Lake Superior two thirds of our supply ranges from 60 to 65 per cent.

As regards copper, a minimum working percentage, amid favorable conditions and with enormous quantities, is usually about three per cent., but in the altogether exceptional deposits of the native metal in the Lake Superior region, copper-rock as low as three fourths of one per cent. has been profitably treated. This or any similar result could only be accomplished with exceptionally efficient management and with a copper rock such as is practically only known on Lake Superior. With the usual type of ore, not enriched by gold or silver, two per cent. is the extreme, and in remote localities from 5 to 10 per cent. may sometimes be too poor.

In southeast Missouri, lead ores are profitably mined which have from 5 to 10 per cent., lead, but they are concentrated to 65 or 70 per cent. before going to the furnace.

Zinc ores at the furnace ought not to yield less than 25 or 30 per cent., and when concentrated or selected they range up to 60 per cent.

The precious metals are expressed in troy ounces to the ton avoirdupois. A troy ounce in a ton is one three-hundredth of one per cent., and the amount is, therefore, very small when stated in percentages. If it be appreciated that in round numbers silver is now worth fifty to sixty cents an ounce, and gold, twenty dollars, some grasp may be had of values. Silver rarely occurs by itself. On the contrary it is obtained in association with lead and copper and the ores are, as a rule, treated primarily for these base metals and then from the latter the

precious metals are later separated. In the base ores there ought to be enough silver to yield a minimum of five dollars or ten ounces in the resulting ton of copper in order to afford enough to pay for separation. Now in a five per cent. ore of copper we have a concentration of twenty tons of ore to yield one ton of pig, or more correctly stated, so as to allow for losses, twenty-one tons to one. We must, therefore, have at least ten ounces of silver in the twenty-one tons, which implies a minimum of about one half ounce per ton. Smelters will only pay a miner for the silver if he has over one half ounce per ton in a copper ore. In a pig of lead, usually called base bullion, it is necessary for profitable extraction to have fifteen ounces of silver. For smelting a lead ore we must possess at least ten per cent. lead and may have seventy. It is, therefore, obvious that from two to twenty ounces silver must be present in the ton of lead ore. The common ranges are ten to fifty ounces or one thirtieth to one sixth of one per cent.

Gold is so cheaply extracted that it may be profitably obtained under favorable circumstances down to one tenth of an ounce in the ton, but the run of ores is from a fourth ounce, or five dollars, to an ounce, or twenty dollars. Ores of course sometimes reach a number of ounces. In copper or lead ores even a twentieth of an ounce may be an object, and in favorably situated gravels to which the hydraulic method may be applied, even as little as seven to ten cents in the cubic yard may be recovered, or some such value as a two-hundredth to a three-hundredth of an ounce per ton.

The tin ores as smelted contain about 70 per cent., but they are all concentrated either by washing gravels in which the percentage is one or less, or else by mining, crushing, and dressing ore in which it ranges from 1.5 to 3 per cent. The tin-bearing gravels represent a concentration from much leaner dissemination in the parent veins and granite. Aluminum ores yield as sold about 30 per cent. of the metal. This is an enrichment as compared with the rocks, though not so striking a one as in the case of other metals. But the great change necessary in aluminum is in the method of combination. It is so tightly locked up in silicates in the rocks as to preclude direct extraction by any known method.

Nickel needs to be present in amounts of several per cent., say two to five, and occurs either alone or with copper. Cobalt is always with it in small amounts. Platinum occurs in exceedingly small percentages. It is almost all obtained from gravels in Russia, and the gravels yielded in 1899 according to C. W. Purington about forty cents to the yard, platinum being quoted in that year at $15 to $18 per ounce. There was, therefore, in the gravels about one fortieth ounce in the yard, or one sixtieth in a ton, or about 5.5 hundred thousandths of a per cent. Platinum in some rocks has been found in amounts of one twentieth to one half ounce, or from 16 hundred thousandths to 16 ten thousandths of one per cent., but they are rare and peculiar types.

In order to be salable manganese ores of themselves must yield about 50 per cent., but if iron is also present they may be as low as 40. Chromium has but one ore, and it must contain about 40 per cent. Of antimony, arsenic, and cobalt it is hardly possible to speak, since, except perhaps in the case of the first, they are unimportant by-products in the metallurgy of other ores.

In summary it may be stated that in the ores the metals must be present in the following amounts:

	Percentage in Ores.	Ounces to Ton.	Percentage in Earth's Crust
Iron,	35–65		4.71
Copper,	2–10		.0000X
Lead,	7–50		.0000X
Zinc,	25–60		.0000X
Silver,	1/12–1/150	2–25	.000000X
Gold,	1/300–1/6,000	1/20–1	.0000000X
Tin,	1–3		.000X–.0000X
Aluminum,	30		8 13
Nickel,	2–5		01
Manganese,	50		07
Chromium,	40		.01

We now have before us some fundamental conceptions from which as a point of departure we may set out upon the real discussion of the subject. We understand the gross composition of the outer earth; we have some idea of the quantitative distribution of the metals in the rocks, especially in the richer instances; finally we have seen the extent to which they must

be concentrated in order that they may be objects of mining. The next step is to establish first the agent or solvent which can effect the collection of the sparsely distributed metals, and second the places where the precipitation of them takes place. We may then inquire more particularly into the source of the agent and the methods of its operation. In order to do this in the time at command I must remorselessly focus attention on the larger and essential features, resolutely avoiding every side issue or minor point, however inviting.

The one solvent which is sufficiently abundant is water, and practically all observers are agreed that for the vast majority of ore deposits it has been the vehicle of concentration. Of course it need not operate alone. On the contrary easily dissolved and ever-present materials, like alkalies, may and undoubtedly do increase its efficiency. It does not operate necessarily as cold water. On the contrary, we all know that the earth grows hotter as we go down, so that descending waters, could not go far without feeling this influence. Volcanoes, too, indicate to us that there are localities where heat is developed in enormous amounts and not far below the surface. There is, therefore, no lack of heat, and we need only be familiar with the Western country to know that there is no lack of hot springs when we take a comprehensive view. As solvents, hot waters are so incomparably superior to cold waters that they appeal to us strongly. We may, therefore, take it as well established that water is the vehicle. The chemical compounds which constitute the ores naturally differ widely in solubility, and no sweeping statements can be made regarding them. Iron, for example, yields very soluble salts and is widely, one might almost say universally, distributed in ordinary waters. Its ores are compounds of the metal with oxygen and in this respect it differs from nearly all others, which are mostly combined with sulphur. Although almost all of them have oxidized compounds, the latter are on the whole very subordinate contributors to our furnaces.

Iron is everywhere present in the rocks, and when exposed to the natural reagents it is one of their most vulnerable elements. It, therefore, presents few difficulties in the way of solution

and concentration by waters which circulate on or near the surface and which perform their reactions under our eyes.

The compounds of copper, lead, zinc, silver, nickel, cobalt, quicksilver, antimony, and arsenic with sulphur present more difficult problems and ones into whose chemistry it is impossible to enter here in any thorough way; but in general it may be said that the solutions were probably hot, that they were in some cases alkaline, in others acid, and that the pressure under which they took up the metals in the depths has been an important factor in the process. The loss of heat and pressure as they rose toward the surface no doubt aided in an important way in the result.

The first condition for the production of an ore-deposit is a waterway. It may be a small crack, or a large fracture, or a porous stratum, but in some such form it must exist. Naturally porous rock affords the simplest case, and provides an easily understood place of precipitation. For example, in the decade of the seventies rather large mines at Silver Reef in southern Utah were based upon an open-textured sandstone into which, and along certain lines, silver-bearing solutions had entered. Wherever they met a fossil leaf or an old stick of wood which had been buried in the rock the dissolved silver was precipitated as sulphide or chloride. Sometimes for no apparent reason the solutions impregnated the rock with ore, but the ore seems to follow along certain lines of fracturing. Again at Silver Cliff, near Rosita in central Colorado, the silver solutions had evidently at one time soaked through a bed of porous volcanic ash, and had impregnated it with ore, which while it lasted was quarried out like so much rock. In the copper district of Keweenaw Point on Lake Superior, the copper-bearing solutions have penetrated in some places an old gravel bed and impregnated it with copper; in other places they have passed along certain courses in vesicular lava flows, and have yielded up to the cavities scales and shoots of native copper.

It has happened at times that the ore-bearing solutions, rising through some crevice, have met a stratum charged with lime, and having spread sideways have apparently been robbed of their metals because the lime precipitated the valuable

minerals. In the Black Hills of South Dakota there are sandstones with beds of calcareous mud rocks in them. Solutions bringing gold have come up through insignificant-looking crevices called "verticals" and have impregnated these mud rocks with long shoots of valuable gold ores. In prospecting in a promising locality the miner, knowing the systematic arrangement of the verticals, and having found the lime-shales, drifts along in them, following a crevice in the hope of breaking into ore. The very extended and productive shoots of lead-silver ores at Leadville, Colo., which have been vigorously and continuously mined since 1877, are found in limestone and usually just underneath sheets of a relatively impervious eruptive rock. They run for long distances and suggest uprising solutions which followed along beneath the eruptive, perhaps checked by it, so that they have replaced the limestone with ore. The limestone must have been a vigorous precipitant of the metallic minerals.

The fracture itself up through which the waters rise may be of considerable size and thus furnish a resting-place for the ore and gangue, as the associated barren mineral is called. A deposit then results which affords a typical fissure vein. The commonest filling is quartz, but at times a large variety of minerals may be present and sometimes in beautifully symmetrical arrangement. In the latter case the uprising waters have first coated each wall with a layer. They have then changed in composition and have deposited a later and different one, and so on until the crack has become filled. Often cavities are left at the centre or sides and are lined with beautiful and shining crystals, which flash and sparkle in the rays of a lamp, like so many gems. There are quartz veins in California which are mined for gold and which seem to have filled clean-cut crevices, wall to wall, for several feet across. More often there is evidence of decided chemical action upon the walls, which may be impregnated with the ore and gangue for some distance away from the fissure. As the source of supply is left, however, the impregnation becomes less and less rich, and finally fades out into barren wall-rock. The enrichment of the walls varies also from point to point, since where the rock is tight the solu-

tions can not spread laterally, but where it is open the impregnation may be extensive. The miner has, therefore, to allow for swells and pinches in his ore.

Of even greater significance than the lateral enrichment is the peculiar arrangement of the valuable ore in a vein that may itself be continuous for long distances although in most places too barren for mining. Cases are, indeed, known in which profitable vein matter has been taken out continuously for perhaps a mile along the strike, but they are relatively rare. The usual experience reveals the ore running diagonally down in the vein filling, and more often than not following the polished grooves in the walls which are called slickensides, and which indicate the direction taken by one wall when it moved on the other during the formation of the fracture. The rich places may terminate in depth as well, and again may be repeated, but they must be anticipated, and for them allowance must be made in any mining operation.

Ores, therefore, gather along subterranean water-ways. They may fill clean-cut fissures, wall to wall; they may impregnate porous wall-rocks on either side; they may even entirely replace soluble rocks like limestones.

We may now raise the question as to the source of the water which accomplishes these results and the further question as to the cause of its circulations.

The nature of the underground waters which are instrumental in filling the veins presents one of the most interesting, if not the most interesting, phase of the problem and one upon which attention has been especially concentrated in later years. The crucial point of the discussion relates to the relative importance of the two kinds of ground-waters, the magmatic, or those from the molten igneous rocks, and the meteoric, or those derived from the rains. The magmatic waters are not phenomena of the daily life and observation of the great majority of civilized peoples, and for this reason they have not received the attention that otherwise would have fallen to their share. Relatively few geologists have the opportunity to view volcanoes in active eruption, and have but disproportionate conceptions of the clouds and clouds of watery vapor which they emit. The

enormous volume has, however, been brought home to us in recent years, with great force, by the outbreak of Mont Pelé, and we of this academy, thanks to the efforts of our fellow-member, Dr. E. O. Hovey of the American Museum of Natural History, have had them placed very vividly before us. It is on the whole not surprising that to the meteoric waters most observers in the past have turned for the chief, if not the only, agent. I will, therefore, first present, as fully as the time admits and as fairly as I may, this older view which still has perhaps the larger number of adherents.

Except in the arid districts rain falls more or less copiously upon the surface of the earth. The largest portion of it runs off in the rivers; the smallest portion evaporates while on the surface, and the intermediate part sinks into the ground, urged on by gravity, and joins the ground-waters. Where crevices of considerable cross-section exist, they conduct the water below in relatively large quantity. Shattered or porous rock will do the same, and we know that open-textured sandstones dipping down from their outcrops and flattening in depth lead water to artesian reservoirs in vast quantity. As passages and crevices grow smaller, the friction on the walls increases and the water moves with greater and greater difficulty. When the passage grows very small, movement practically ceases. The flow of water through pipes is a very old matter of investigation, and all engineers who deal with problems of water supply for cities or with the circulation of water for any of its countless applications in daily life must be familiar with its laws. Friction is such an important factor that only by the larger natural crevices can the meteoric waters move downward in any important quantity or very appreciable velocity. They do sink, of course, and come to comparative rest at greater or less distance from the surface and yield the supplies of underground water upon which we draw.

The section of the rocks which stands between the surface and the ground-water is the arena of active change and is that part of the earth's crust in which the meteoric waters exercise their greatest effect. Rocks within this zone are in constant process of decay and disintegration. Oxidation, involving

the production of sulphuric acid from the natural metallic sulphides, is actively in progress. Carbonic acid enters also with the meteoric waters. The rocks are open in texture and favorably situated for maximum change. From this zone we can well imagine that all the finely divided metallic particles which are widely and sparsely distributed in the rocks go into solution and tend to migrate downward into the quiet and relatively motionless ground-water. If the acid solutions escape the precipitating action of some alkaline reagent such as limestone they may even reach the ground-waters, and their dissolved burdens may be contributed to this reservoir, but the greater portion seems to be deposited at the level of the ground-water itself or at moderate distances below it. Impressed by these phenomena, which present a true cause of solution, and influenced by their familiar and everyday character, we may build up on the basis of them a general conception of the source of the metallic minerals dissolved in those aqueous solutions which are recognized by all to be the agents for the filling of the veins.

Let us now focus attention on the ground-water. This saturates the rocks, fills the crevices, and forces the miner who sinks his shaft to pump, much against his natural inclination. The vast majority of mines are of no great depth, and the natural conclusion of our earlier observers, based on this experience, has been that the ground-waters extend downward, saturating the strata of the earth to the limit of possible cavities, distances which vary from 1,000 to more than 30,000 feet. To this must be added another familiar phenomenon. The interior temperature of the earth increases at a fairly definite ratio of about one degree Fahrenheit for each 60–100 feet of descent. In round numbers, if we start with a place of the climatic conditions of New York—that is, with a mean annual temperature of about 51°, we should on descending 10,000 feet below the surface find a temperature of about 212°, and if we go still deeper it would be still greater. Of course, under the burden of the overlying column of water, the actual boiling points for the several depths would be greater, and it is a question whether the increase of temperature would

overcome the increase of pressure and the consequent rise of the boiling point, so as to convert this water into steam, cause great increase in its elasticity, decrease in its specific gravity, and thereby promote circulations. At all events, the rise in temperature would cause expansion of the liquid, would disturb equilibrium, and to this degree would promote circulations.

There is one other possible motive power. The meteoric waters enter the rocky strata of the globe at elevated points, sink downward, meet the ground-water at altitudes above the neighboring valleys, and establish thereby what we call head. In consequence they often yield springs. If we imagine the head to be effective to considerable depths we have again the deep-seated waters under pressure, which after their long and devious journey through the rocks may cause them to rise elsewhere as springs. The head may in small degree be aided by the expansion of the uprising heated column whose specific gravity is thereby lowered as compared with the descending colder column.

May we now draw all these facts and supposed or assumed phenomena into one whole?

The descending meteoric waters become charged with dissolved earthy and metallic minerals in their downward, their deep-seated lateral, and perhaps also at the beginning of their heated uprising journey. They are urged on by the head of the longer and colder descending column and by the interior heat. They gather together from many smaller channels into larger issuing trunk channels. They rise from regions of heat and pressure which favor solution, into colder regions of precipitation and crystallization. They deposit in these upper zones their burden of dissolved metallic and earthy minerals and yield thus the veins from which the miner draws his ore.

This conception is based on phenomena of which the greater part are the results of everyday experience. It is attractive, reasonable, and is on the whole the one which has been most trusted in the past. Doubtless it has the widest circle of adherents to-day. It is, however, open to certain grave objections which are gaining slow but certain support.

The conception of the extent of the ground-water in depth, for example, is flatly opposed to our experience in those hitherto few but yearly increasing deep mines which go below 1,500 or 2,000 feet. Wherever deep shafts are located in regions other than those of expiring but not dead volcanic action, they have passed *through* the ground-water, and if this is carefully impounded in the upper levels of the mines, and not allowed to follow the workings downward, it is found that there is not only less and less water but that the deep levels are often dry and dusty. Along this line of investigation, Mr. John W. Finch, recently the State Geologist of Colorado, has reached the conclusion after wide experience with deep mines that the ground-waters are limited, in the usual experience, to about 1,000 feet from the surface and that only the upper layer of this is in motion and available for springs.

Artesian wells do extend in many cases to depths much greater than this and bring supplies of water to the surface, but their very existence implies waters impounded and in a state of rest.

To this objection that the ground-waters are shallow it has been replied that when the veins were being formed the rocks were open-textured and admitted of circulation, but subsequently the cavities and waterways became plugged by the deposition of minerals by a process technically called cementation and, the supply being cut off, they now appear dry. There must, however, in order to make the "head" effective have once been a continuous column of water which introduced the materials for cementation. It is at least difficult to understand how a process which could only progress by the introduction of material in very dilute solution should by the agency of crystallization drive out the only means of its production. Some residue of water must necessarily remain locked up in the partially cemented rock. This residue we, of course, do not find where rocks are dry and drifts are dusty. In many cases also, where deep cross-cuts have penetrated the fresh wall-rock of mines, cementation if present has been so slight as to escape detection.

If we once admit that this conclusion is well based, it removes

the very foundation from beneath the conception of the meteoric waters and tumbles the whole structure in a heap of ruins.

While I would not wish to positively make so sweeping a statement as this about a question involving so many uncertainties, there is nevertheless a growing conviction among a not inconsiderable group of geologists that the rocky crust of the earth is much tighter and less open to the passage of descending waters than has been generally believed; and that the phenomena of springs, which have so much influenced conclusions in the past, affect only a comparatively shallow, overlying section. Such phenomena of cementation as we see are probably in large part due to the action of water stored up by the sediments when originally deposited and carried down by them with burial. Under pressure a relatively small amount of water may be an important vehicle for recrystallization.

It has been assumed in the above presentation of the case of the meteoric waters that they are able to leach out of the deep-seated wall-rocks the finely disseminated particles of the metallic minerals, but the conviction has been growing in my own mind that we have been inclined to overrate the probability of this action in our discussions. In the first place our knowledge of the presence of the metals in the rocks themselves is based upon the assay of samples almost always gathered from exposures in mining districts. The rock has been sought in as fresh and unaltered a condition as possible, and endeavors have been made to guard against the possible introduction of the metallic contents by those same waters which have filled the neighboring veins. But if we admit or assume that the assay values are original in the rock, and, in case the latter is igneous, if we believe that the metallic minerals have crystallized out with the other bases from the molten magma, we are yet confronted with the fact that their very presence and detection in the rock shows that they have escaped leaching even though they occur in a district where underground circulations have been especially active. From the results which we have in hand it is quite as justifiable to argue that the metals in the rocks are proof against the leaching action of underground circulations as that they fall victims to it. These considera-

tions tend to restrict the activities of the meteoric waters to the *vadose* region as Posepny calls it, i.e., that belt of the rocks which stands between the permanent water-level and the surface. Within it is an active area of solution, as we have all recognized for many years, but, as previously stated, experience shows that the metals which go into solution in it strongly tend to precipitate at or not far below the water-level itself.

It is of interest, however, to seek some quantitative expression of the problem, and the assays given above furnish the necessary data.

I have taken the values of the several metals which have been found by the assays of what were in most cases believed to be normal wall-rocks, selecting those of igneous nature because experience shows them to be the richest. The percentages have been turned into pounds of the metal per ton of rock; this latter value has then been recast into pounds of the most probable natural compound or mineral in each case. I have next calculated the volume of a cube corresponding to the last weight, and by extracting its cube root have found the length of the edge of such cube. If now we assume a rock of a specific gravity of 2.70, which is a fair average value, and allow it 11 to 12 cubic feet to the ton, or say 20,000 cubic inches, the edge of the cube-ton will be 27.14 inches. The ratio of the edge of the cube of metallic mineral to the edge of the cube-ton of enclosing rock will give us an idea of the chance that a crack large enough to form a solution-water-way will have of intersecting that amount of contained metallic mineral. Of course in endeavoring to establish this quantitative conception I realize that the metallic mineral is not in one cube, and that through a cube-ton of rock more than one crack passes; but I assume that the fineness of division of the metallic mineral practically keeps pace with the lessening width and close spacing of the crevices. It is also realized that the shape of the minerals is not cubical. I am convinced from microscopic study of rocks and the small size of the metallic particles that their subdivision certainly keeps pace with any conceivable solution-cracks, and that no great error is involved in the first assumption made. The sides of a cube represent three planes which intersect at

right angles and which are mathematically equivalent to any series of planes intersecting at oblique angles. Hence if we consider as cubes the subdivisions formed in our rock mass by any series of intersecting cracks, there are three sets of planes, any one of which might intersect the cube of ore. We must, therefore, multiply the ratio of probability that any single set will intersect it by three in order to have the correct expression. The chance that a crack, of the width of the cubic edge of the enclosed mineral, will strike that cube is given by the ratios in the last column, which ratios I assume hold good with increasing fineness of subdivision both of metallic minerals and of cracks.

	Per Cent. by Analysis.	Pounds per Ton.	Pounds Chalcopyrite.	Volume Cubic Inches.	Edge of Cube.	Ratio of Edge to Edge of Cube-ton Rock.	Ratio of Probability.
Copper.	.009	.18	.52	3.42	1.5	1/18	1/6
			Galena.				
Lead.	.0011	.022	.025	.092	.45	1/60	1/20
	.008	.16	.186	.700	.89	1/31	1/10
	.004	.08	.002	.340	.70	1/39	1/13
			Zincblende.				
Zinc.	.0048	.096	.128	.90	.97	1/35	1/12
	.009	.180	.240	1.60	1.17	1/21	1/7
			Argentite.				
Silver.	.00007	.0014	.0016	.006	.18	1/148	1/49
	.00016	.0032	.0037	.014	.24	1/113	1/38
			Gold.				
Gold.	.00002	.0004	.0004	.00065	.086	1/313	1/104
	.00004	.0008	.0008	.00130	.109	1/249	1/83

From the table it is evident that the chances vary from a maximum in the case of copper of one in six through various intermediate values to a minimum for gold of one in over one hundred. This is equivalent to saying that, with cracks whose total width bears the same relation to the width of the rock mass as is borne by the diameter of the particle of ore, the chance of crossing a particle varies from one in six to one in one hundred. Or we may say that with cracks of this spacing

from one sixth to one hundredth of the contained metallic mineral might be leached out.[1] When, therefore, as is often the case in monographs upon the geology of a mining district, inferences are drawn as to the possibility of deriving the ore of a vein by the leaching of wall-rocks whose metallic contents have been proved by assay, the total available contents ought to be divided by a number from six to one hundred if the above reasoning is correct. This diminution will tend to modify in an important manner our belief in the probability of such processes as have been hitherto advocated. We may justly raise the following questions: How closely set, as a matter of fact, are the cracks which are large enough to furnish solution water-ways in the above rocks, and can we reach any definite conception regarding their distribution? Some quantitative idea of the relations may be obtained from the tests of the recorded absorptive capacity of the igneous rocks which are employed as building stone. G. P. Merrill in his valuable work on *Stones for Building and Decoration*, pp. 459, has given these values for thirty-three granites and four diabases and gabbros. They vary for the granites from a maximum of one twentieth to a minimum of one seven hundred and fourth. I have averaged them all and have obtained one two hundred and thirty-seventh as the result. That is, if we take a cubic inch of granite and thoroughly dry it, it will absorb water up to one two hundred and thirty-seventh of its weight. The volume of this water indicates the open spaces or voids in the stone. The average of the specific gravities of the thirty-three granites is 2.647. If, by the aid of this value, we turn our weight of water into volume we find that its volume is one ninetieth that of the rock. For the four diabases and gabbros, similarly treated, the ratio of absorption is one three hundred and tenth; the specific gravity is 2.776 and the ratio of volume one one hundred and tenth. We can express all this more intelligibly by saying

[1] With regard to the flow of waters through crevices and the relation of the flow to varying diameters or widths, a very lucid statement will be found in President C. R. Van Hise's valuable paper in the *Transactions of the American Institute of Mining Engineers*, XXX, [illegible], and in his monograph on Metamorphism.

that, if we assume a cube of granite and if we combine all its cavities into one crack passing through it, parallel to one of its sides, the width of the crack will be to the edge of the cube as 1 to 90. In the diabases and gabbros, similarly treated, the ratio will be 1 to 110. These values are very nearly the same as the average of the ratios of the edges of the cubes of rock and ore given in the table on p. 226, it being 1 to 104. We may conclude, therefore, that in so far as we can check the previous conclusion by experimental data it is not far from the truth.

It may be stated that the porphyritic igneous rocks which have furnished nearly all the samples for the above analyses are as a rule extremely dense, and that their absorptive capacity is more nearly that of the compact granites than the open-textured ones. It is highly improbable that underground water circulates through these rocks to any appreciable degree except along cracks which have been produced in the mechanical way either by contraction in cooling and crystallizing, or by faulting and earth movements. The cracks from faulting are very limited in extent and in the greater number of our mining districts they affect but narrow belts, small fractions of the total. Of the cracks from cooling and crystallizing those of us who have seen rock faces in cross-cuts and drifts underground, where excavations have been driven away from the veins proper, can form some idea, if we eliminate the shattering due to blasting. My own impression is that in rocks a thousand feet or so below the surface such cracks are rather widely spaced, and that, when checked in a general way by the ratios just given, these rocks are decidedly unfavorable materials from which the slowly moving meteoric ground-waters (if such exist) may extract such limited and finely distributed contents of the metals.

I have also endeavored to check the conclusions by the recorded experience in cyaniding gold ores in which fine crushing is so important, and I can not resist the conviction that we have been inclined to believe the leaching of compact and subterranean masses of rock a much easier and more probable process than the attainable data warrant.

As soon, however, as we deal with the open-textured fragmental sediments and volcanic tuffs and breccias the permeability is so enhanced as to make their leaching a comparatively simple matter. Yet, so far as the available data go, they are poor in the metals or else are open to the suspicion of secondary impregnation. They certainly have been seldom, if ever, selected by students of mining regions as the probable source of the metals in the veins.

Should the above objections to the efficiency of the meteoric waters seem to be well established, or at least to have weight, it follows that the arena where they are most, if not chiefly, effective is the vadose region, between the surface and the level of the ground-water. Undoubtedly from this section they take the metals into solution and carry them down. But it is equally true that they lose a large part of this burden, especially in the case of copper, lead, and zinc, at or near the level of the ground-water and are particularly efficient in the secondary enrichment of already formed but comparatively lean ore-bodies.

Let us now turn to the magmatic waters. That the floods of lava which reach the surface are heavily charged with them, there is no doubt. So heavily charged are they that Professor Edouard Suess, of Vienna, and our fellow-member Professor Robert T. Hill, of New York, have seen reason for the conclusion that even the oceanic waters have in the earlier stages of the earth's history been derived from volcanoes rather than, in accordance with the old belief, volcanoes derive their steam from downward percolating sea-water. From vents like Mont Pelée, which in periods of explosive outbreaks yield no molten lava, the vapors rise in such volume that cubic miles become our standards of measurement.

There is no reason to believe that many of the igneous rocks which do not reach the surface are any less rich, and when they rise so near to the upper world that their emissions may attain the surface, we must assign to the resulting waters a very important part in the underground economy.

This general question has attracted more attention in Europe in recent years as regards hot springs than in America. So many health resorts and watering places are located upon them

that they are very important foundations of local institutions and profitable enterprises. Professor Suess, whom I have earlier cited, delivered an address a few years ago at an anniversary celebration in Carlsbad, Bohemia, in which he stated that Rosiwal, who had studied the Carlsbad district, could not detect any agreement between the run of the rainfall and the outflow of the springs, and that both the unvarying composition and amount through wet seasons and dry were opposed to a meteoric source. Water, therefore, from subterranean igneous rocks, well known to exist in the locality, was believed to be the source of the springs. The same general line of investigation has led Dr. Rudolf Delkeskamp, of Giessen, and other observers to similar conclusions for additional springs, so that magmatic waters have assumed a prominence in this respect which leaves little doubt as to their actual development and importance.

All familiar with Western and Southwestern mining regions know, as a matter of experience, that the metalliferous veins are almost always associated with intrusive rocks, and that in very many cases the period of ore formation can be shown to have followed hard upon the entrance of the eruptive. The conclusion has, therefore, been natural and inevitable that the magmatic waters have been, if not the sole vehicle of introduction, yet the preponderating one.

With regard to their emission from the cooling and crystallizing mass of molten material we are not, perhaps, entirely clear or well established in our thought. So long as the mass is at high temperatures the water is potentially present as dissociated hydrogen and oxygen. We are not well informed as to just what is the chemical behavior of these gases with regard to the elements of the metallic minerals. Hydrochloric acid gas is certainly a widely distributed associate. If, as seems probable, these gases can serve, alone or with other elements, as vehicles for the removal of the constituents of the ores and the gangue, the possibilities of ubiquitous egress are best while the igneous rock is entirely or largely molten. In part even the phenomena of crystallization of the rock-forming minerals themselves may be occasioned by the loss of the dissolved gases. Through molten and still fluid rock the gases might bubble outward if

the pressure were insufficient to restrain them and would, were their chemical powers sufficient, have opportunity to take up even sparsely distributed metals.

On the other hand if their emission, as seems more probable, is in largest part a function of the stage of solidification and takes place gradually while the mass is congealing, or soon thereafter, then they must depart along crevices and openings whose ratio to the entire mass would be similar to those given above. They might have, and probably do have, an enhanced ability to dissolve out in a searching and thorough manner the finely distributed metallic particles as compared with relatively cold meteoric waters which might later permeate the rock; but as regards the problem of leaching, the general relations of crevices to mass are much the same for both, and it holds also true that the discovery of the metals by assay of igneous rocks proves that all the original contents have not been taken, by either process.

We may, however, consider an igneous mass of rock as the source of the water even if not of the ores and gangue, and then we have a well-established reservoir for this solvent in a highly heated condition and at the necessary depths within the earth. Both from its parent mass and from the overlying rocks traversed by it, it may take the metals and gangue.

In the upward and especially in the closing journey, meteoric waters may mingle with the magmatic, and as temperatures and pressures fall, the precipitation of dissolved burdens takes place and our ore-bodies are believed to result. Gradually the source of water and its store of energy become exhausted; circulations die out and the period of vein-formation, comparatively brief, geologically speaking, closes. Secondary enrichment through the agency of the meteoric waters alone remains to influence the character of the deposit of ore. In brief, and so far as the process of formation of our veins in the Western mining districts is concerned, this is the conception which has been gaining adherents year by year and which, on the whole, most fully accords with our observed geologic relations. It accords with them, I may add, in several other important particulars upon which I have not time to dwell.

In closing I may state that, speculative and uncertain as our solution of the problem of the metalliferous veins may seem, it yet is involved in a most important way with the practical opening of the veins and with our anticipations for the future production of the metals. Every intelligent manager, superintendent or engineer must plan the development work of his mine with some conception of the way in which his ore-body originated, and even if he alternates, or lets his mind play lightly from waters meteoric to waters magmatic, over this problem he must ponder. On its scientific side and to an active and reflective mind it is no drawback that the problem is yet in some respects elusive and that its solution is not yet a matter of mathematical demonstration. In science the solved problems lose their interest; it is the undecided ones that attract and call for all the resources which the investigator can bring to bear upon them. Among those problems which are of great practical importance, which enter in a far-reaching way into our national life and which irresistibly rivet the attention of the observer, there is none with which the problem of the metalliferous veins suffers by comparison.

SPECIAL INDEXES TO PART I, ARTICLE I.

A PHYTOGEOGRAPHICAL SKETCH OF THE ALTAMAHA GRIT REGION OF THE COASTAL PLAIN OF GEORGIA.

PLANT NAMES.

This index is intended to be complete as far as families, species, and varieties are concerned, but generic names are not indexed separately, except in cases where a statement is made which refers to several or all of the species of a genus and no particular species is mentioned, and in the case of generic synonyms in the catalogue of species.

The names of families are printed in small capitals, and those of genera and species in ordinary lower-case, except where the generic name or all the specific names cited under it are synonyms, in which case italics are used. All specific names of synonyms are printed in italics (whether the generic name is or not), and those of accepted species in Roman. The names of genera and species not members of this flora (mentioned on page 330 and elsewhere) are enclosed in parentheses, and common names in quotations. No typographical distinction is made here between native and introduced species, but all but one or two of the latter may be recognized by the fact that they are first referred to on page 114 or 115.

Figures in heavy type after the name of a family refer to the pages in the catalogue of species where its representatives in the region are listed, and after that of a species, to the page where its bibliography and distribution are given. Figures in parentheses refer to pages where the species in question is inadvertently mentioned under a different name, usually on account of recent changes in nomenclature.

This index contains about 1550 subject entries and 4000 page-references. Of about 875 valid species (including weeds) listed, 82 are mentioned only once, and their status in the region may be regarded as doubtful; 318 are mentioned only twice, and more information about most of these is needed; 474 are mentioned more than twice; 283 more than 3 times; 156 more than 4 times; 91 more than 5 times; 61 more than 6 times, and so on, ending with two mentioned 22 times, one 23, and one 24 times, the last four being trees. The average species is mentioned 3½ times.

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LIST OF IMPORTANT CORRECTIONS

Part I, Article No. 1

PAGE

1, line 2, for September read November.
37, " 13, " (2) read (1).
46, " 38, insert the figure 2 before Asclepias humistrata.
62, last footnote, insert footnote index (2) and change 21 to 25
68, line 5, for Fimbrystylis read Fimbristylis.
82, " 32, for (21) read (26).
84, " 23, " cilliatifolius read ciliatifolius.
84, " 32, " Carolainina read Caroliniana.
98, " 38, " 26 read 27.
104, " 23, " Uniolia read Uniola.
116, " 2, " *spermm* read *spermum*.
118, " 21, " 2 read 1.
151, " 15, " Grac read Gray.
192, " 12, after OGEECHEE LIME, insert (Pl. XXI, fig. 1).
227, " 12, for **MIMOSAEÆ** read **MIMOSACEÆ**.
227, " 23, " **KRAMERIAEÆ** read **KRAMERIACEÆ**.
234, " 22, insert at end of line:—236. 1906.
264, " 3, for Charleston read Charlton.
271, " 5, after THOMAS insert County.
271, lines 6 and 7, for *Nympha æorbiculata* read *Nymphæa orbiculata*.
272, punctuation marks at ends of lines 1 and 3 are interchanged.
287, line 9, insert C. before **Martindalei**.
293, " 21, for *ejunicdus* read *ejuncidus*.
299, " 29, " **pæcox** read **præcox**.
318, line 5, insert 2:280. 1803. after Fl.
328, in explanation of table, for 18 read 19.
333, in table at top of page, second bracket has slipped down one space.
346, line 5, for 111:27 read 11:127.
354, " 16, " 6: read 5:
355, last line, for *83* read *1–83*.

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